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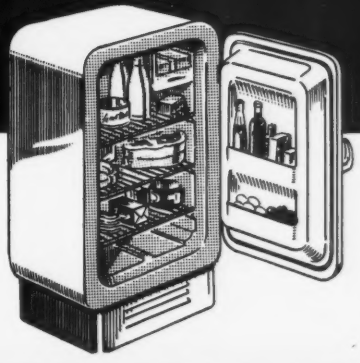
Refrigerator Liner – vacuum formed by the 'Formvac Airslip' technique developed by Messrs. Hydro-Chemie. using Erinoid extruded high impact polystyrene sheeting, grade CP.20X, with high gloss finish on one side, Thickness .125".

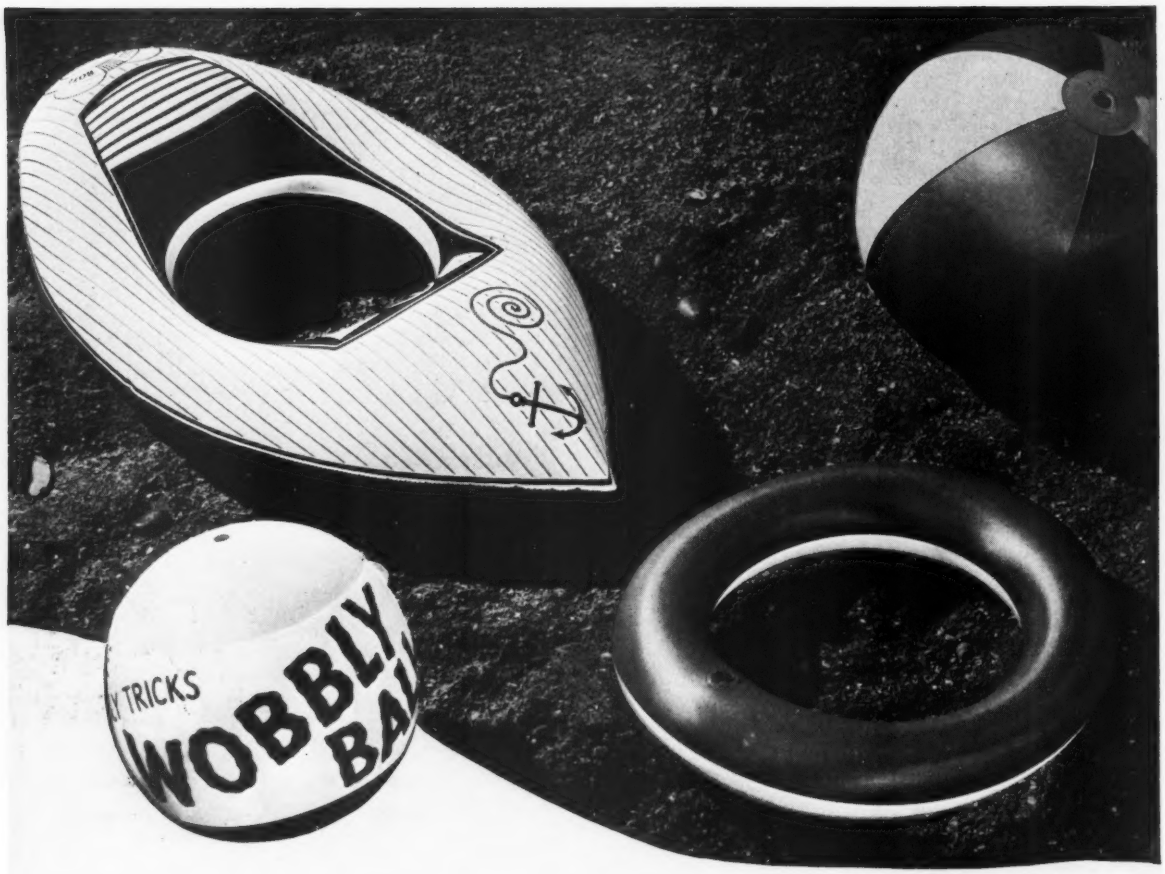
Dimensions of moulding 18" x 33" x 12½"



Erinoid

Styrene Copolymer Sheeting

ERINOID LIMITED • STROUD • GLOUCESTERSHIRE



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Inflatable beach toys made by Cascelloid from laminated VELBEX P.V.C. produced by BX Plastics. Light, strong and colourful, VELBEX stands up exceptionally well to rough handling and all the hidden hazards of the beach, such as oil, grease and tar.

Velbex **P.V.C. SHEETING**

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powerful newly-conceived, built-in oildynamic circuits

increased plasticizing capacity

higher injection rapidity

SPECIFICATIONS

model	NB 28	NB 30 Record	NB 40	NB 60 E	NB 100	NB 120 E	NB 160
injection capacity oz.	1	1÷	1.4	2.1	3.5	4.2	5.6
hourly plasticizing capacity lbs.	6.6	12	15.4	28.6	26.4	53	39.6

			FULLY AUTOMATIC				
model	NB 220 E	NB 360/520 E	R 01	R 02	R 6 FA	R 12 FA	R 20 FA
injection capacity oz.	7.7	13-19	0.53	0.85	2-3	4-6	7.7-11.6
hourly plasticizing capacity lbs.	75	97	7.7	7.7	29	53	75

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TAS/FS. 518

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' Extrusion ' grades are available in any required flow and in special formulations, too—it just depends on the individual end product. Typical applications for ' Extrusion ' grade are: thin walled tubular containers, drinking straws, sheeting, and rods for tool handles.
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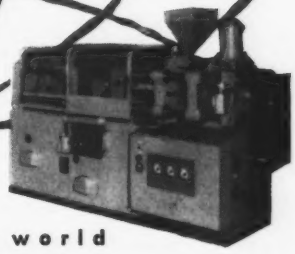

More than 2000 BATTENFELD INJECTION MOULDING MACHINES are operating in 48 countries all over the world

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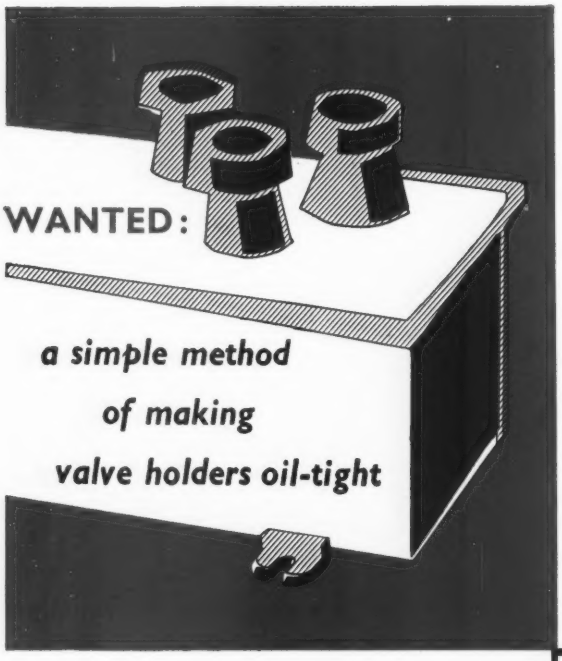

These valve holders, made by London Transformer Products Ltd., have been developed because of the great difficulty experienced in effecting a completely oil-tight seal on standard valve bases when mounted on oil-cooled transformers. The problem required a material which would withstand high working voltages under adverse conditions of service.

FOUND: *Epikote Resins with the necessary qualities*

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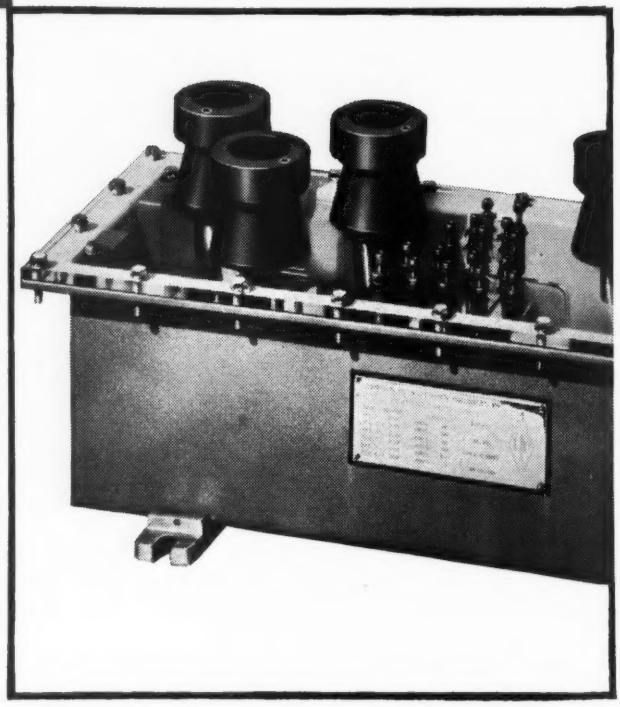
The technical resources behind the Shell organisation will work in close co-operation to solve your production problems by the use of "Epikote" resins.



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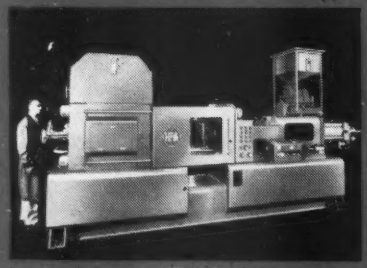
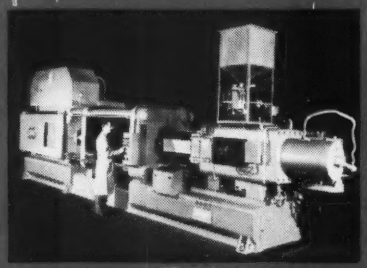


Model 300-H-12 12/16 oz.

Plasticizing Capacity	135 lb/hr.
Size of die platen	30" x 33"
Maximum die space	30" deep
Floor area	18' 6" x 5' 5"



Model 800-H-48 48/64 oz.

Plasticizing Capacity	300 lb/hr.
Size of die platen	55" x 55"
Maximum die space	55"
Floor area	28' 3" x 7' 1"

Plastics

in every way except floor area

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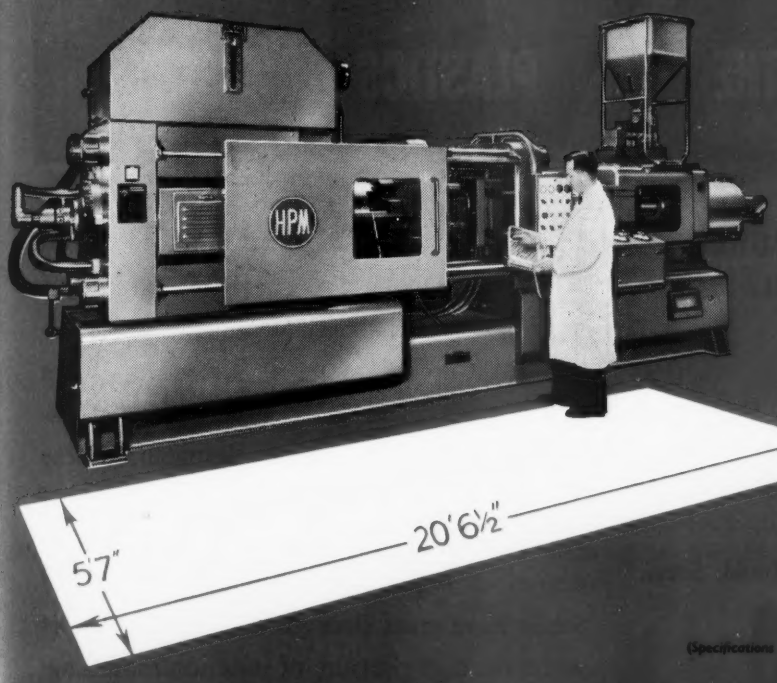

Model 400-H-20 **20/28 oz.**

Plasticizing Capacity	200 lb/hr.
Size of die platen	36" x 42"
Maximum die space	40" deep
Floor area	20' 6½" x 5' 7"

(Specifications in accordance with recommendations of British Plastics Federation)

Injection Moulding Machines

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Telephone : Coventry 40351

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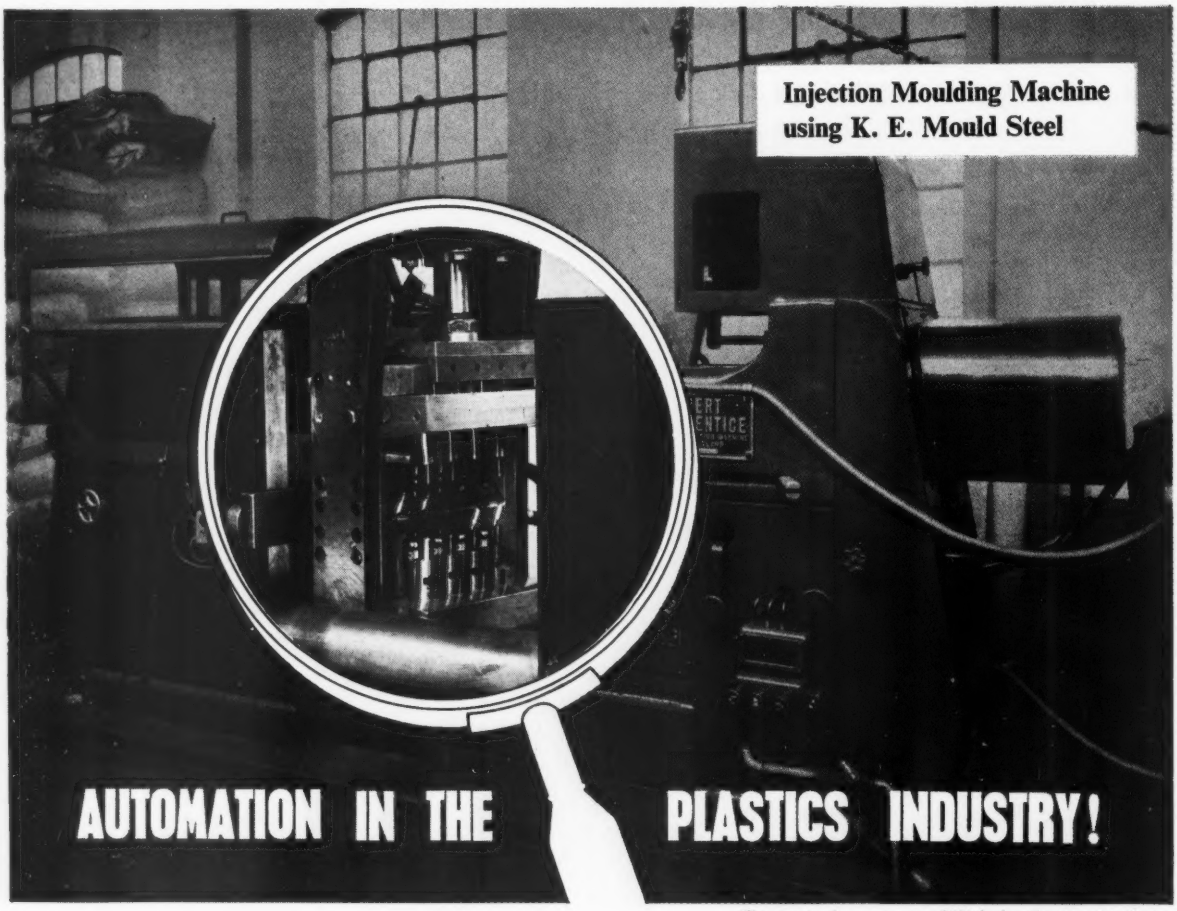

Illustration by courtesy of Wolseley Engineering Ltd.

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(K)(E) 961 1½% Carbon 12% Chrome High Duty Mould Steel.

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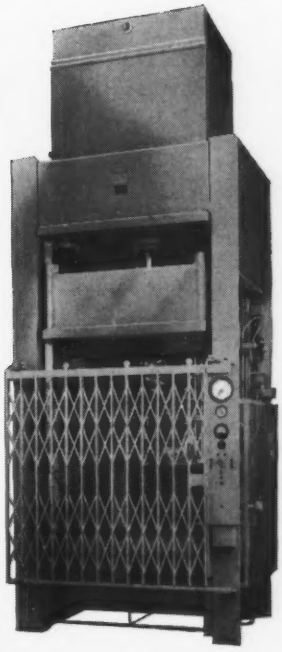
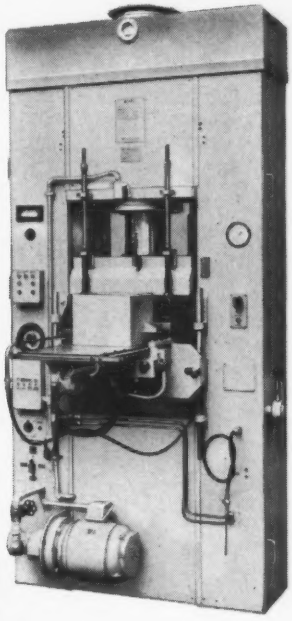
BIPEL MAKE *every kind of* compression press *you can think of*



Infinitely variable pressure 10-50 tons or, alternatively, 10-150 tons. Three closing speeds and a high initial mould parting force of 25 tons for the first 2 in. of rising

The injection unit is easily removable so the press can be used as a normal compression press. Injection Ram pressure 12.6 tons (at working pressure 1000 p.s.i.)

An easily attached feeding and stripping mechanism combined with standard auto-control provides a quickly converted fully automatic press, ideal for long runs



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NB 45 MASTER	mm 45
NB 60 MASTER	mm 60
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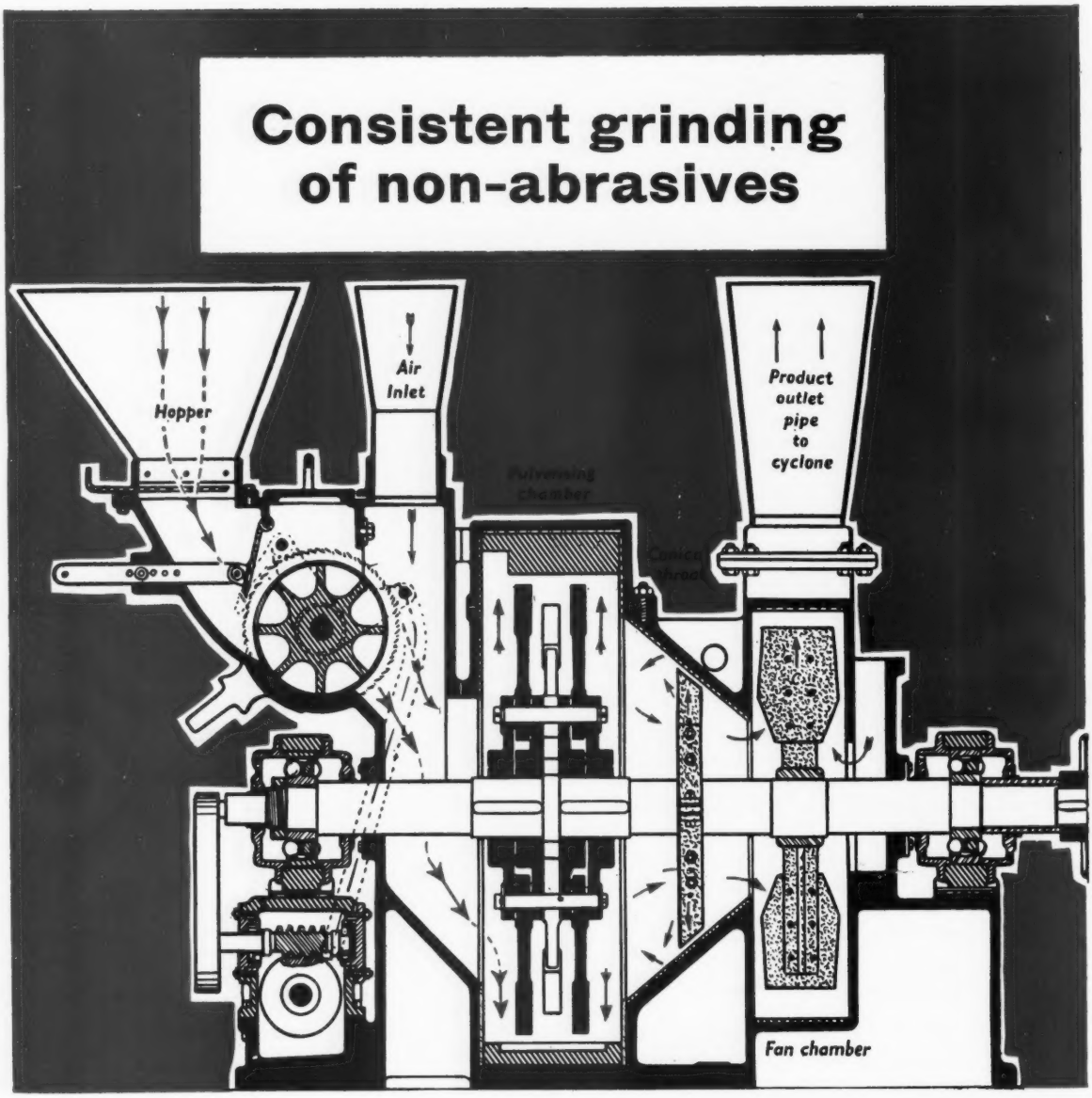

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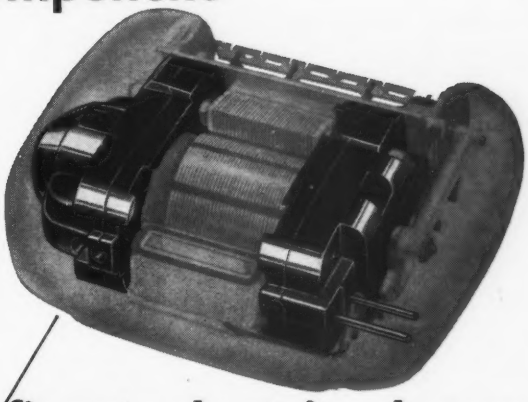

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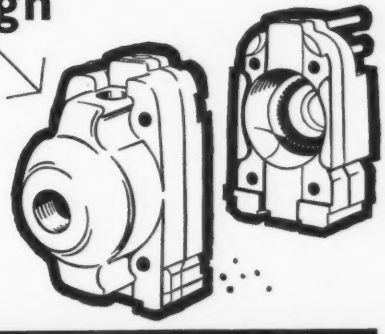
only the best is good enough

For these transfer mouldings which are illustrated by kind permission of Sunbeam Electric Ltd. we selected a thermosetting material. Your enquiries would be welcomed.



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Car and bus heater housings, air ducts, fan blades, seat bases and sides, armrest foundations, door panels, window strips

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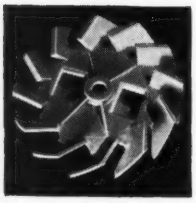
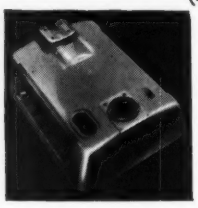
precision mouldings
of strength and stability



Ralsin injection moulding powder

(NYLON 11)

Even by current high standards, Ralsin (Nylon 11) injection moulding powder is exceptional—and custom moulders will quickly acknowledge the fact. Ralsin precision mouldings—strong, lightweight and dimensionally stable are already being applied with singular success in the fields of accountancy and computing machinery, automotive engineering and textiles. Gears made from Ralsin are silent, self-lubricating; a slight 'give' in the material permits perfect engagement and protracted use without wear. Ralsin has excellent electrical insulation properties, is indifferent to water, heat and cold and will withstand temperatures of 100°C continuously.



What the custom moulder will want to know about Ralsin moulding procedure, physical properties and special suitabilities, is contained in Publication No. TD/R/2. Engineers and Designers are invited to request a copy.

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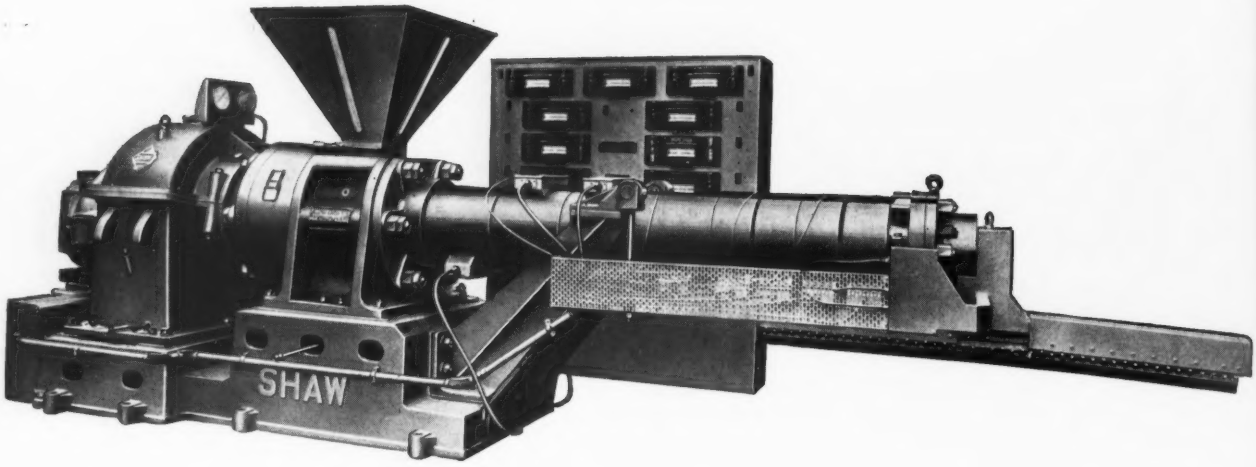

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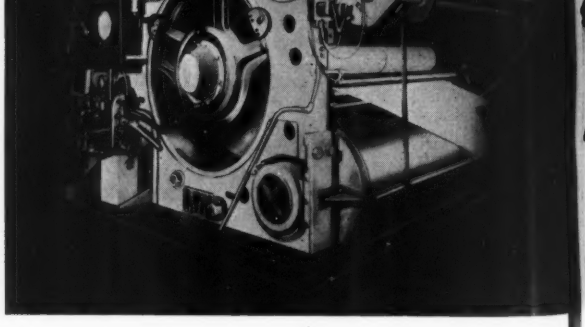

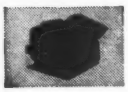

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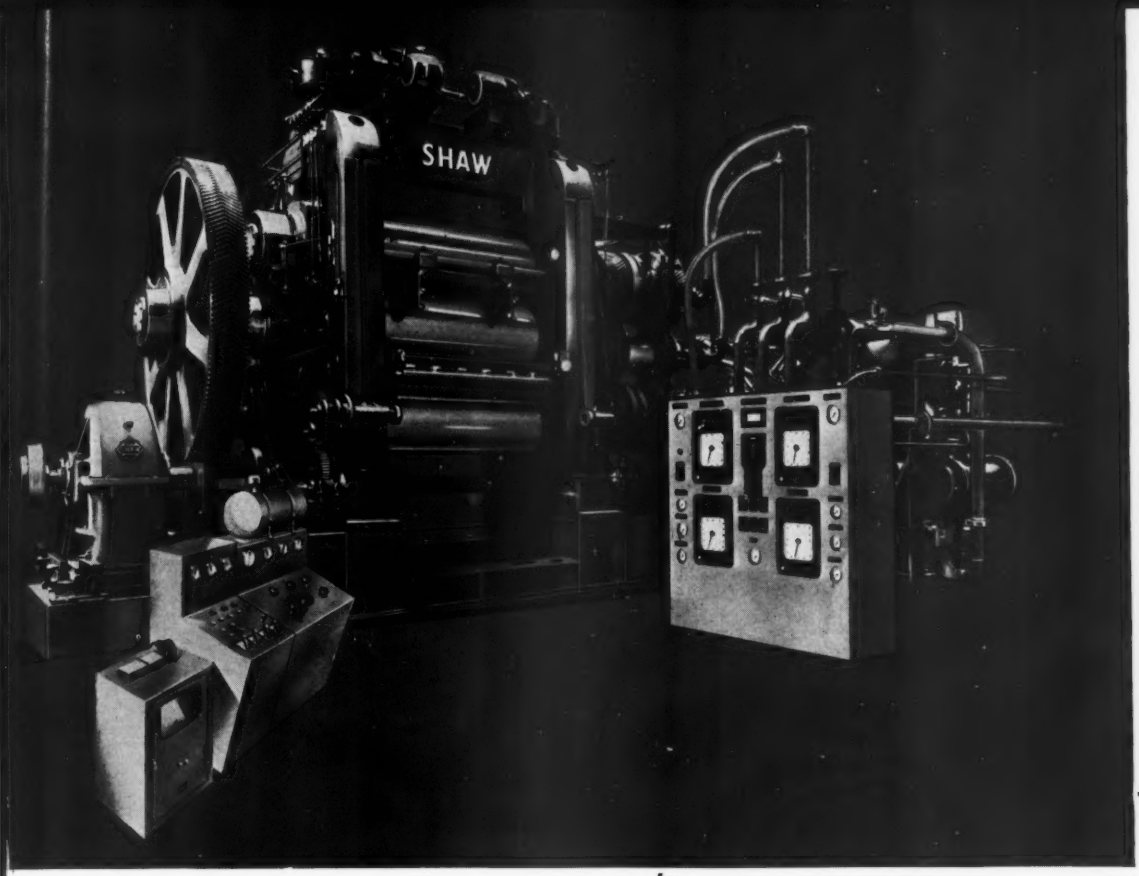

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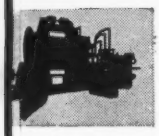

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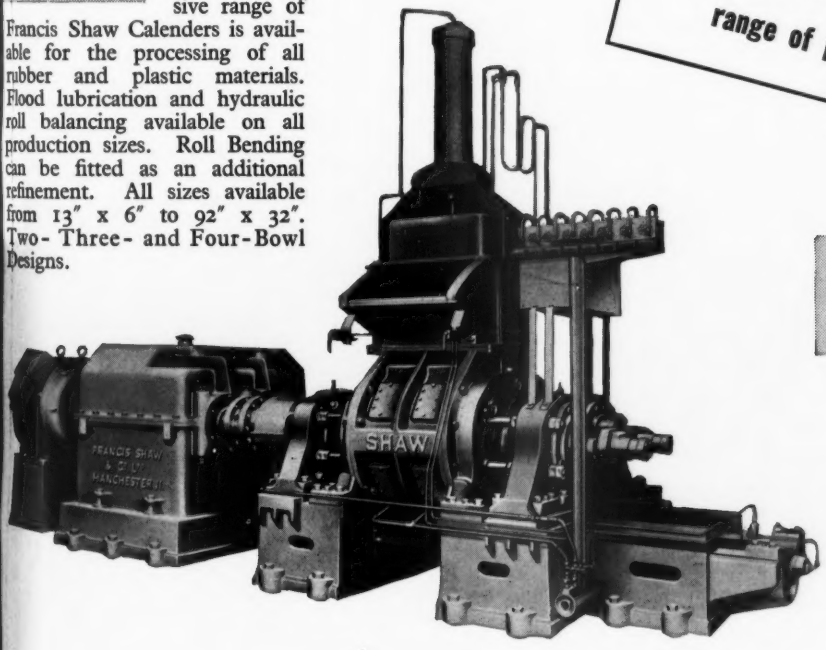

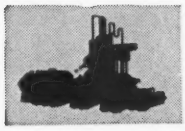

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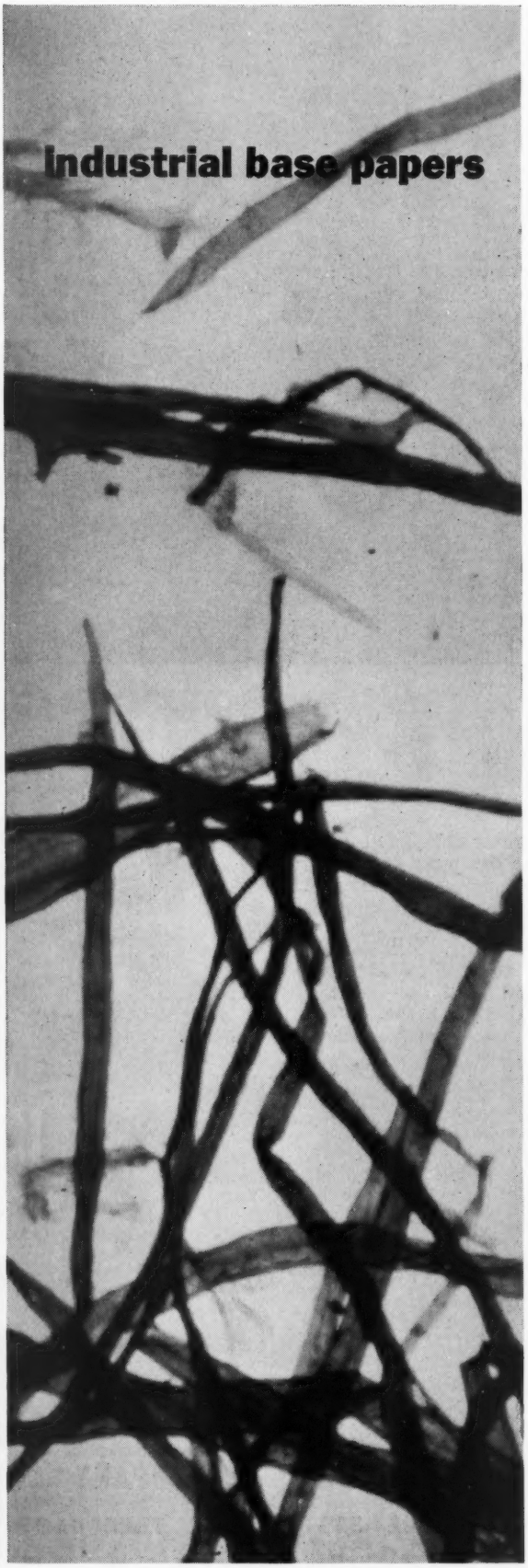

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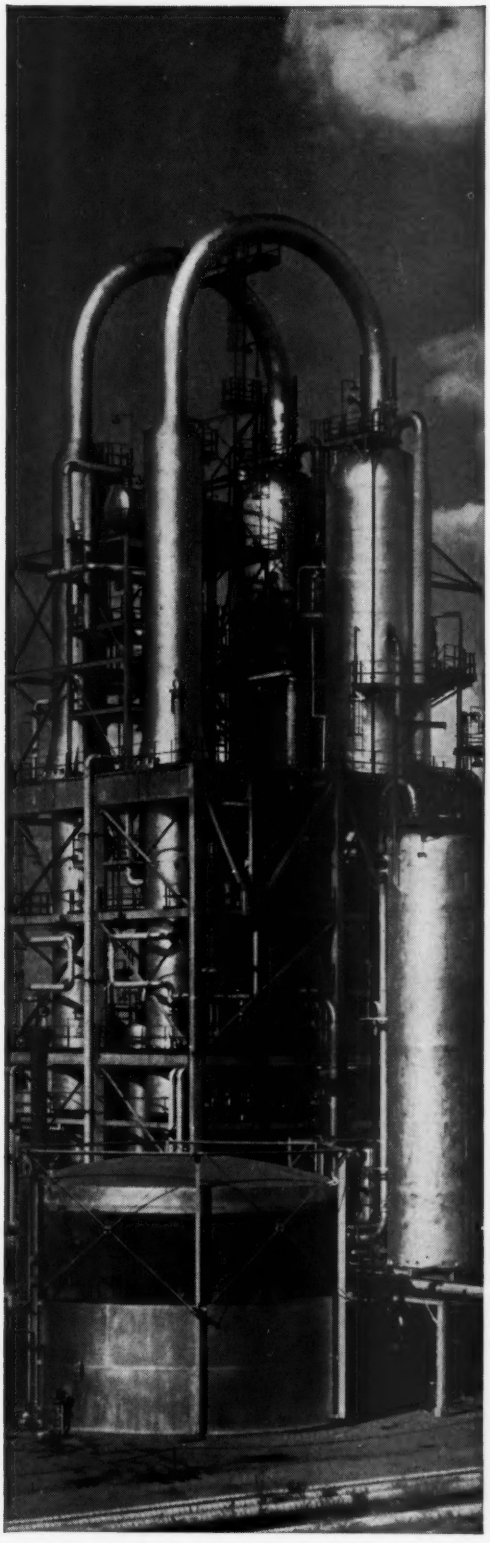

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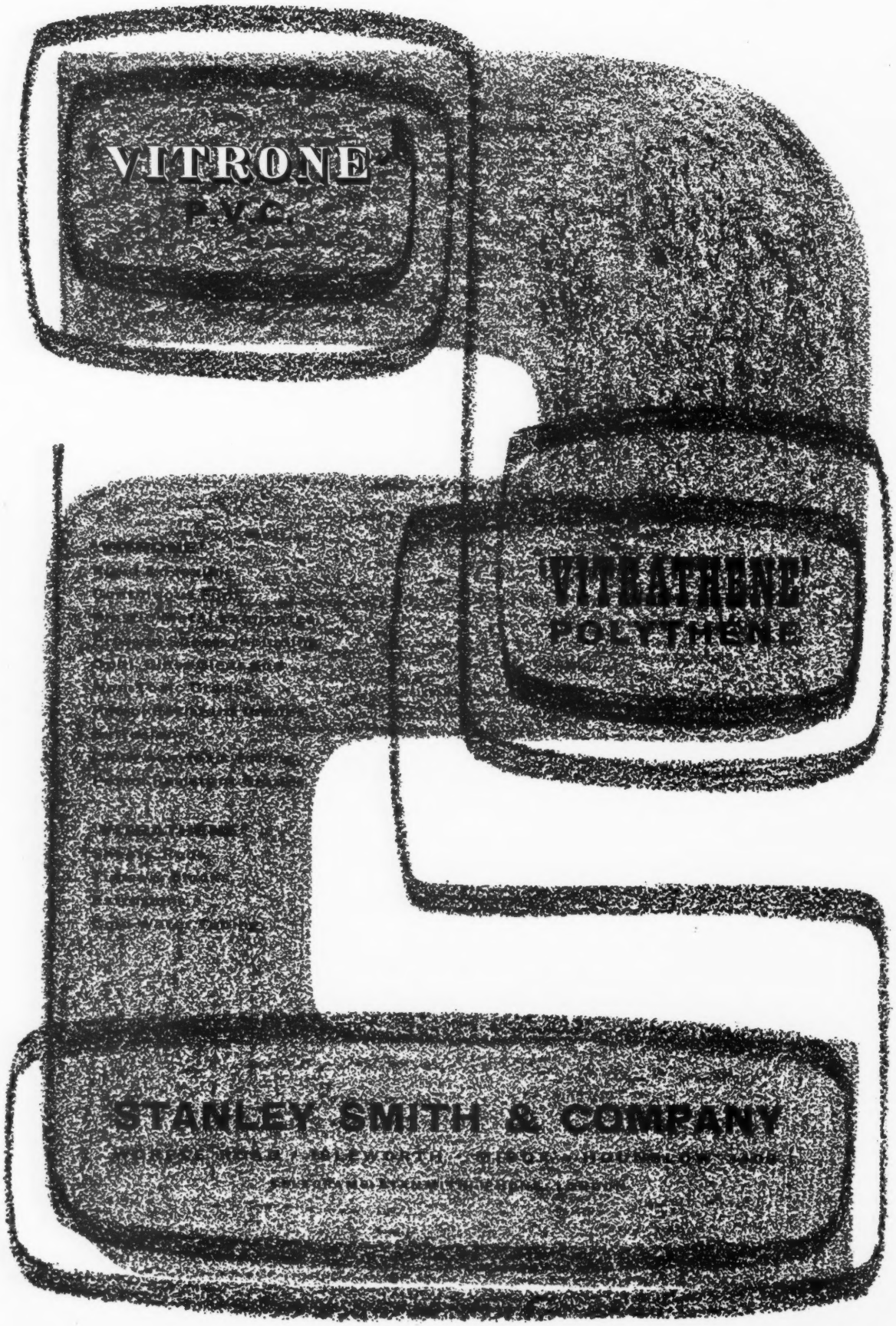
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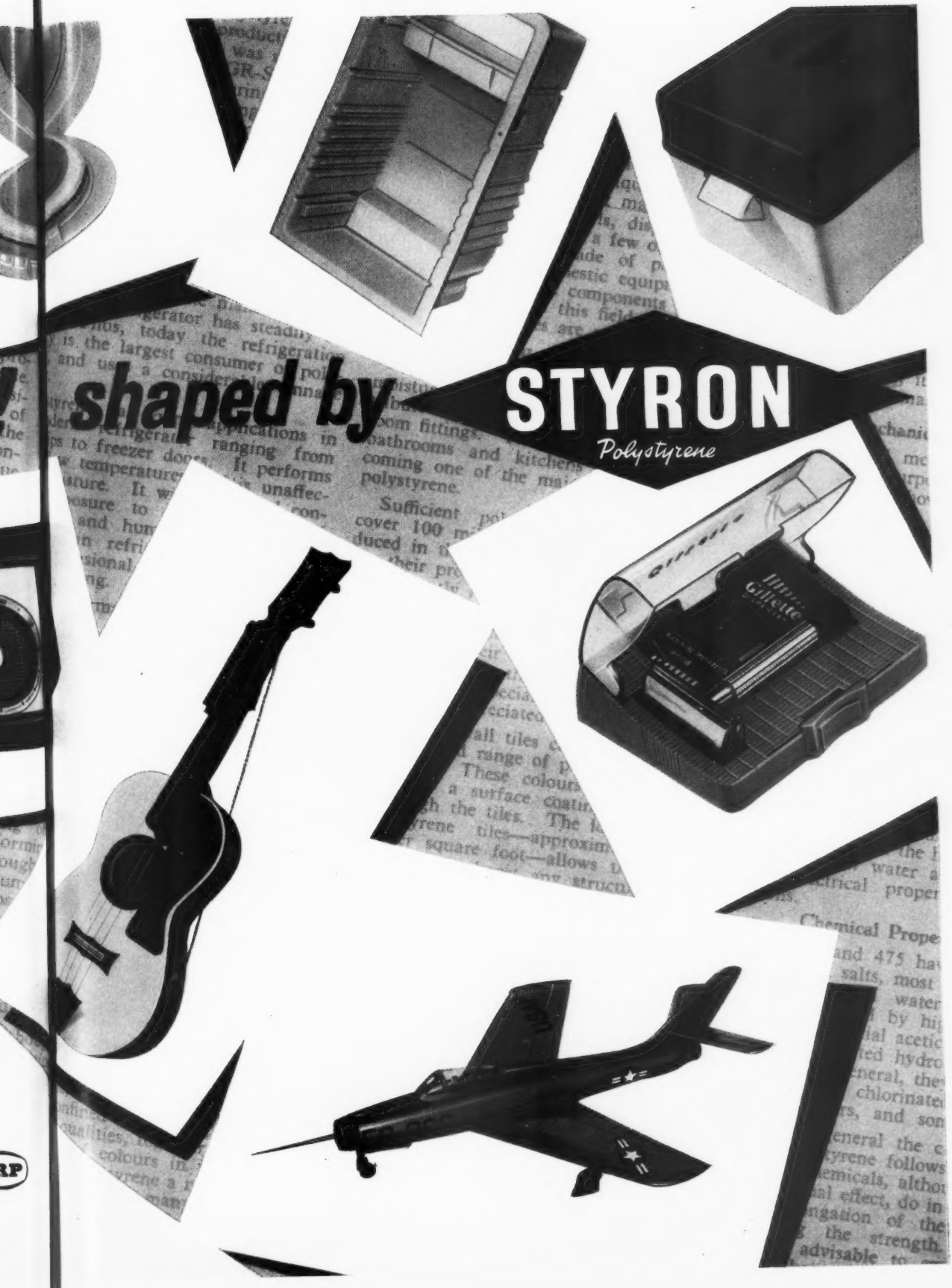
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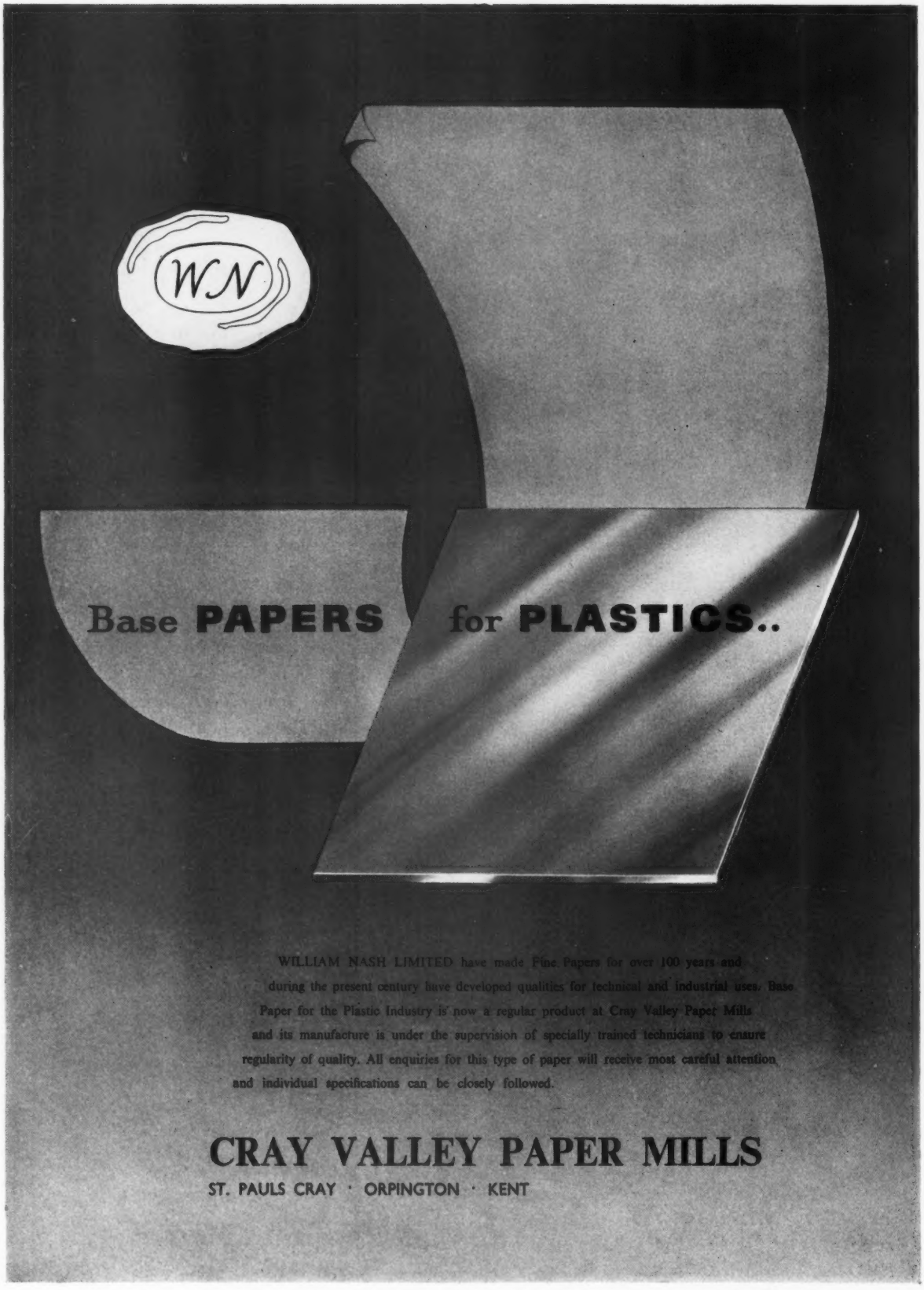
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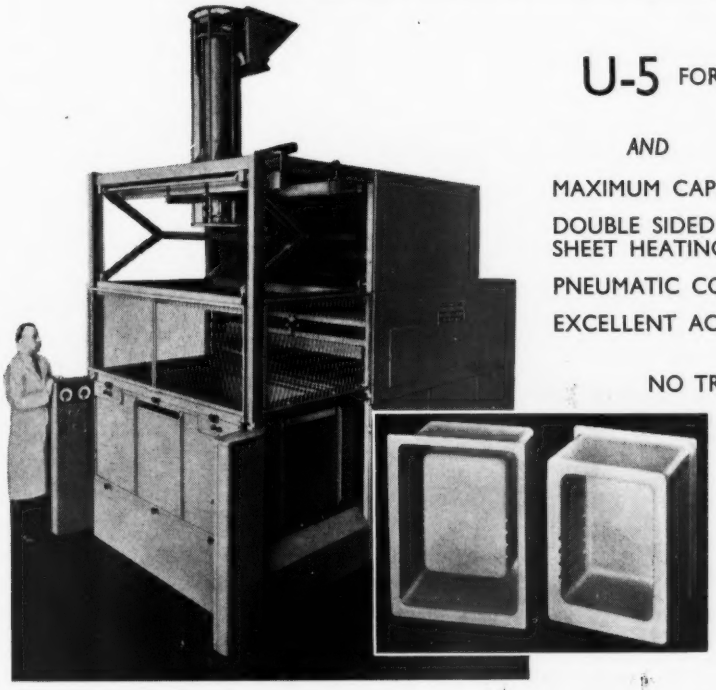

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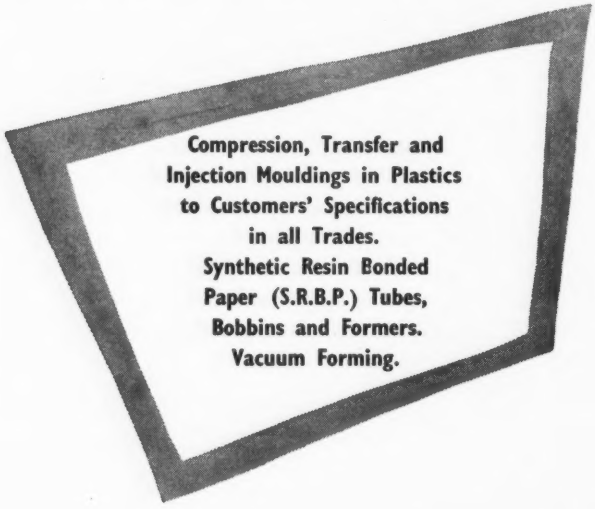

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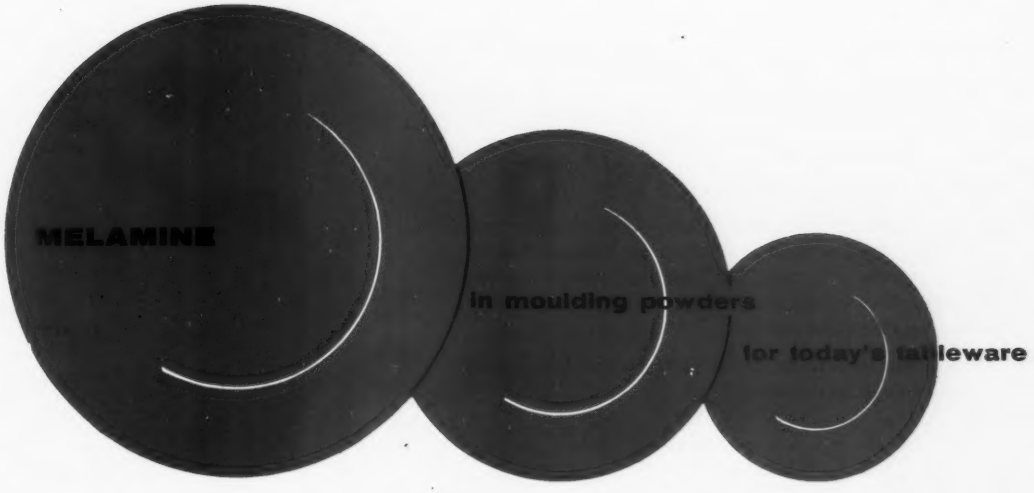

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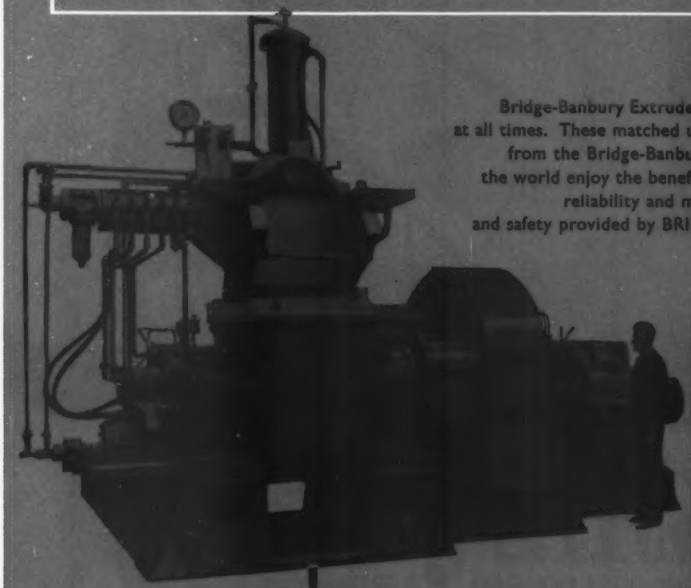

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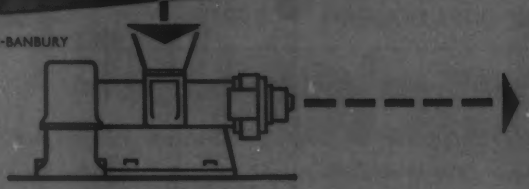

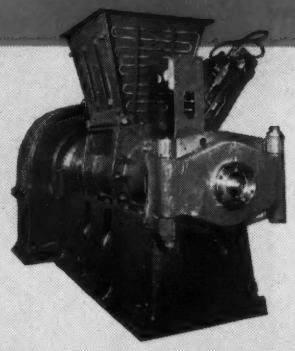

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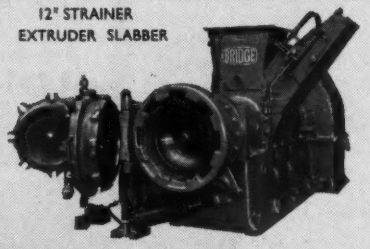

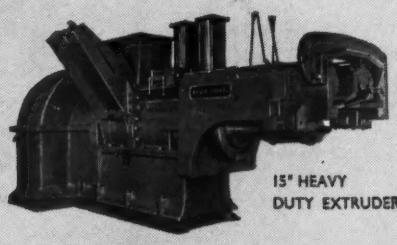

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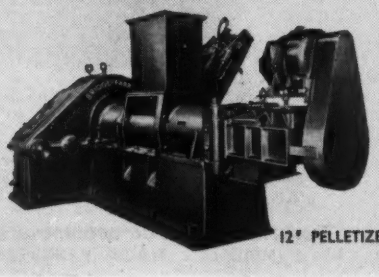

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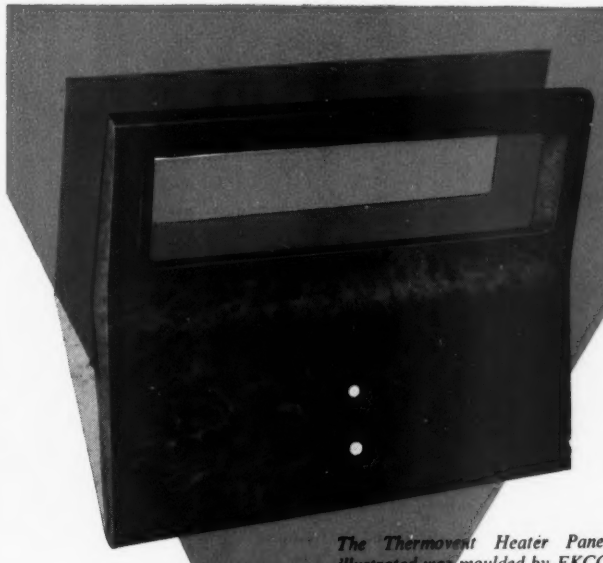

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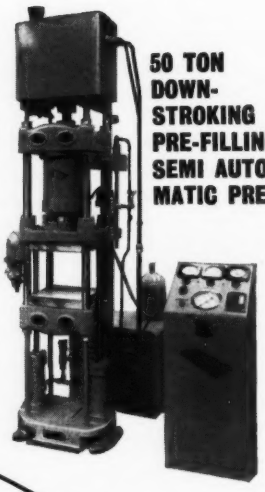

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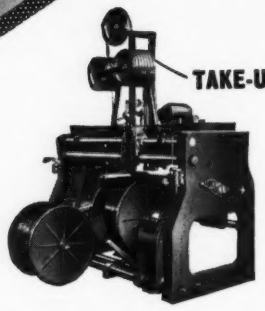

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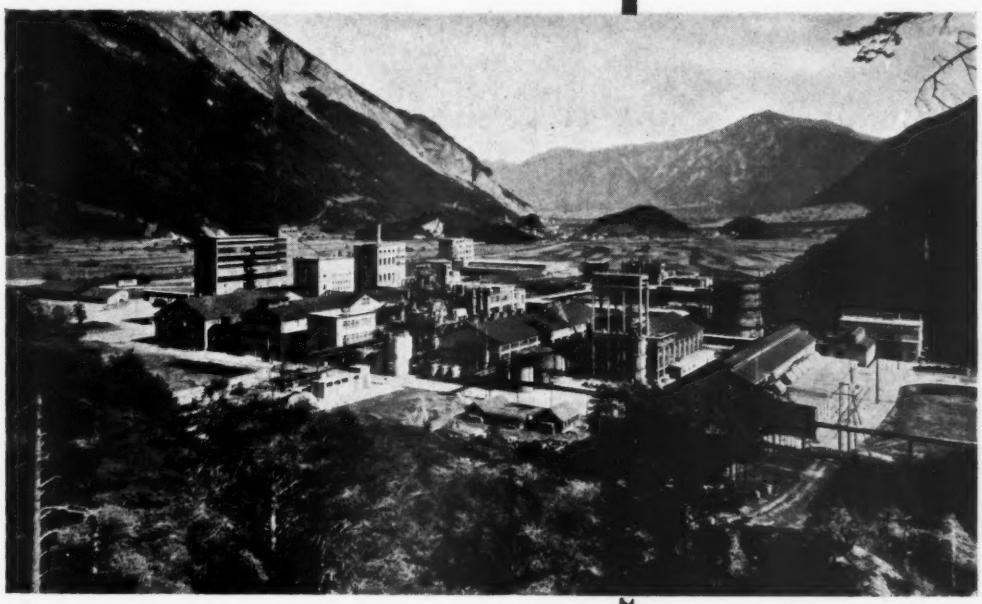

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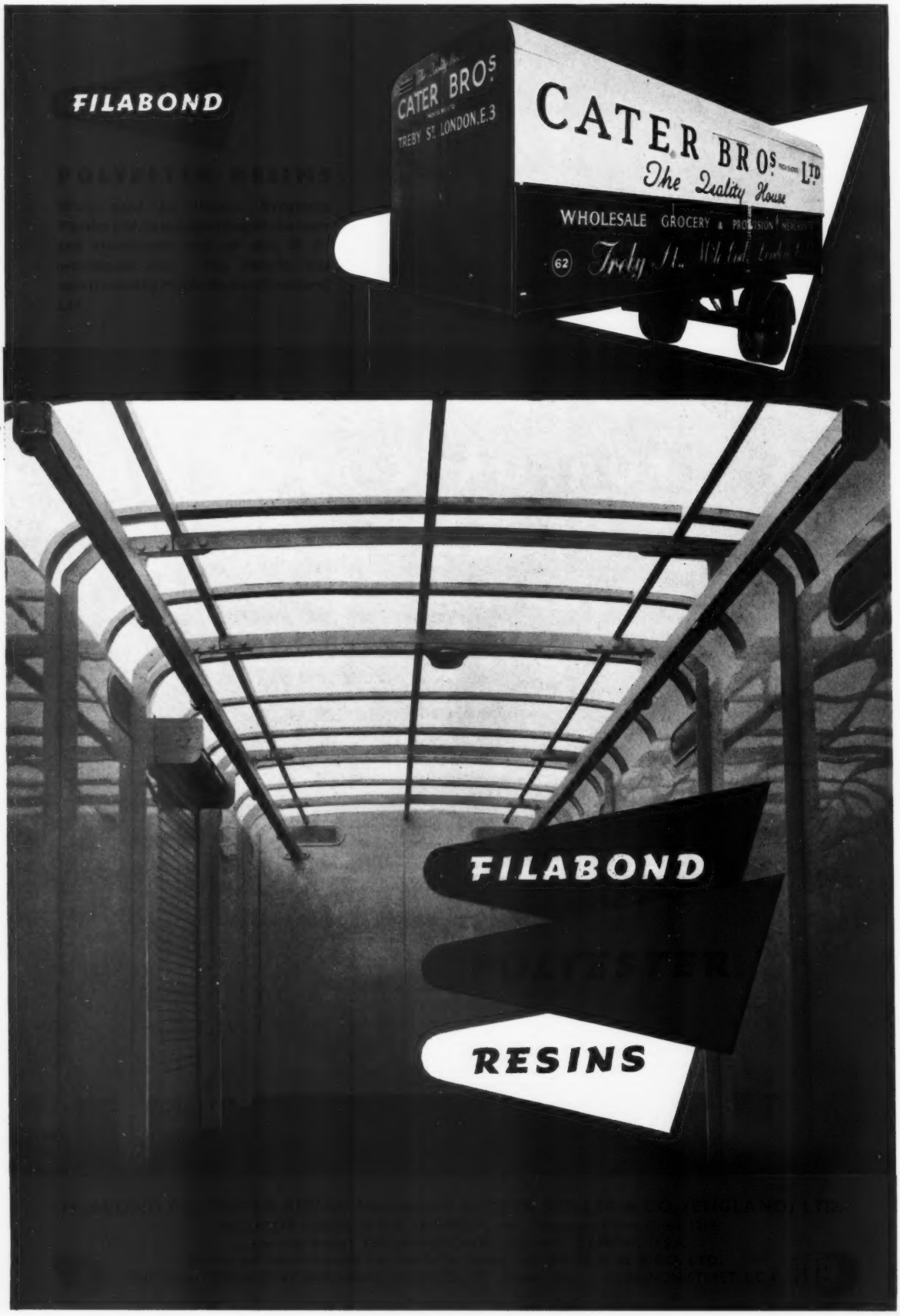
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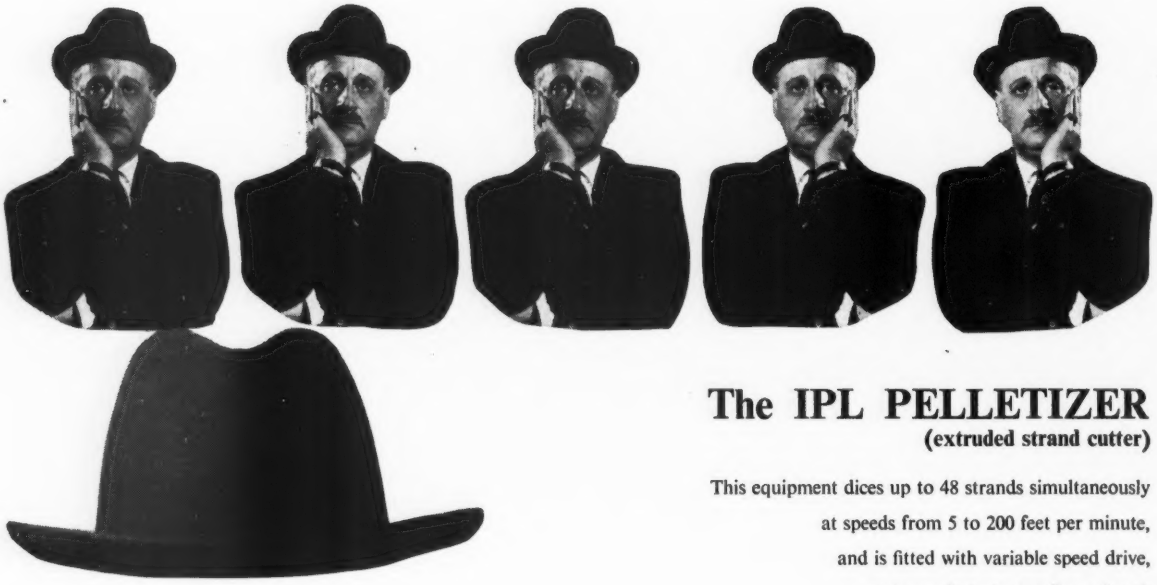

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CONTENTS

	Page
Editorials	115
Moulding Powder and Shot	116
The New Diakons	117
Polycarbonate Resins, by R. J. Thompson and K. B. Goldblum	122
High Polymer Science and Technology in the United States, Part 2, by J. Glazer	126
World's Industry Employs Plastics	129
Spark Machining Aids Die Sinking	131
Pigmenting Plastics	132
New Materials from the U.S.A.	133
New Productions	134
Herbert/Reed Prentice 4 oz. Injection Machine	136
Plastics News	138
Automation Equipment	142
Talking Shop	143
Europe and Petroleum Chemicals, by P. N. Collinswood, C. F. M. Mackintosh, and H. Steiner	145
Plastics in Stencil Manufacture	149
New Factory for Cincinatti	149
Plastics in the Laboratory, Part 2, by G. Haim	150
Patent Review	153

Injection Moulding Diakon at the Witton Moulded Insulation Works of the G.E.C.

EDITOR: M. D. CURWEN, B.Sc., F.R.I.C.
ASSISTANT EDITOR: C. W. WELCH

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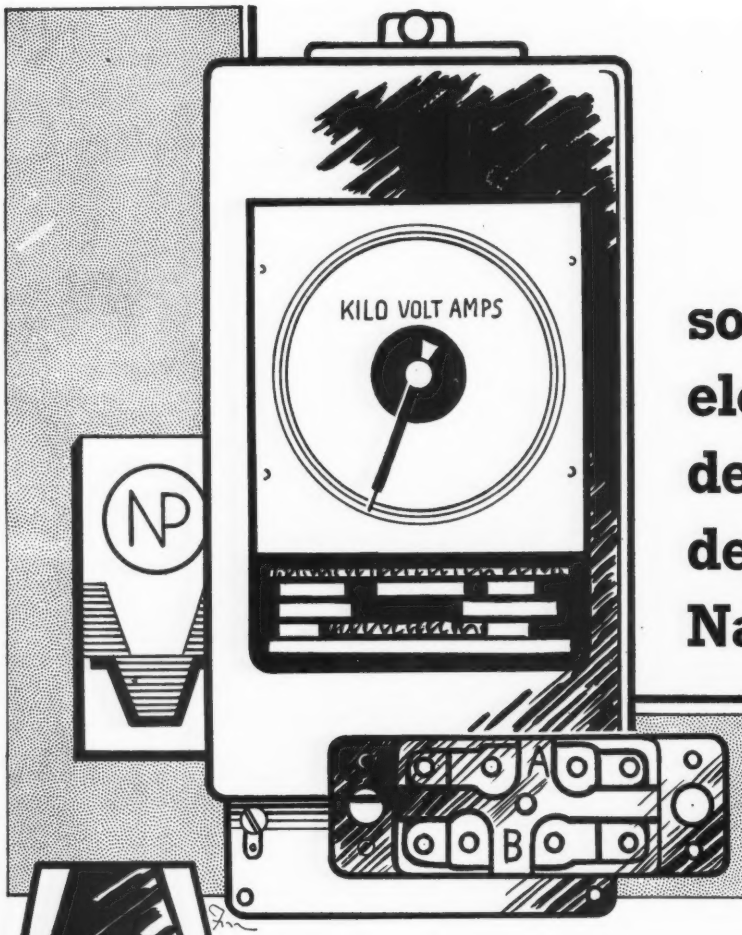

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Plastics

VOL. XXIII No. 247 APRIL, 1958

EDITORIALS

New-Old "Diakon"

MORE than 20 years ago in I.C.I.'s office at Millbank, the late Major Maclean kept on his desk his pet show-piece —a telephone set moulded from transparent acrylic plastic. We well remember trying to photograph it for this journal but succeeded in getting a picture of the electrical contents only, illuminated by splashes of light in the wrong places.

It was Major Maclean's job to sell this moulding powder which was trade-marked "Diakon," as well as the already well-known and, for 1937, the fairly widely used "Perspex," the cast sheet or block form of the same material: polymethyl methacrylate. The latter indeed had proved an almost immediate success among the fabricators for its exceptional toughness, its splendid optical transparency and high dimensional stability; it had thus, in spite of its high cost, found ready acceptance for aircraft wind-screens, canopies and gun-turrets, optical lenses and prisms, and as a new raw material for the art of turning—in our first volume we had published photographs of the beautiful watch-cases and plaques created by Lady Margaret Crawford.

"Diakon," however, followed no such clear and smooth path to success. Cellulose acetate and polystyrene could not readily be ousted among moulders by such a high-priced material in spite of its exceptional properties. What is more important, it was difficult to mould and easy to degrade on the old type injection machine with its inadequate power and inadequate temperature control; failures were frequent. Nevertheless, even in 1937, completely successful mouldings had been made by some moulders and we remember reporting especially the remarkable achievement of Ebonestos Ltd. who produced a large 30 mph. speed limit sign. This circular moulding was composed of 17,000 tiny "lenses" or rather mirrors to reflect light at night. It was a remarkable moulding made on a beautifully machined mould, and was duly admired at the 1938 British Industries Fair.

During the 1939–1945 war little was heard about "Diakon" nor indeed during the succeeding years. Today there is much to relate. Indeed it appears that the problems have been under continual examination throughout the years and that complete success has now been achieved. The story is told in considerable detail on pages 117 to 121 of this issue.

The research has entailed the examination of two obvious concomitants. First, the production of the polymer in a form that would ensure greater fluidity in the screw or mould of the machines, thus eliminating completely the rubbery, more easily depolymerizable, nature of the original plastic. This has been achieved by the production of a polymer of closely controllable average molecular weight lower than that of the original "Diakon," but which is not permitted to fall below a given specification, for again, degradation would occur. Secondly, the modern injection machine and the modern extruder, with their improved power and heat transmissions and close controls, are generally wholly suitable for the modern "Diakon."

In congratulating I.C.I. on this admirable piece of scientific and industrial research and for its obstinacy in continuing it, we may well ponder on its implications. "Diakon"—shall we say, "Diakon Redivivus" although it never really died ?—is known to many of the older moulders who must have hoped for its "rebirth." As we have related, we saw a few of the original mouldings 20 or more years ago, but it was only this month that we saw extrusions of it for the first time. This will clearly raise the problems of injection and extrusion of "Diakon" versus the blowing and pressure forming of "Perspex," many fabrications in which are now being produced on something approaching a mass-produced scale. (Economics will undoubtedly determine the final balance between the alternative processes.)

Nor is there any doubt that the new "Diakon" will be cheaper than the original type. We cannot guess what the price will be when fuller production is reached (present supplies are obviously limited) but we *can* guess that it will in any event make formidable inroads into the existing fields held by other thermoplastic moulding compounds. Major Maclean's hopes may yet be fulfilled.

The Motor Industry—A Challenge

THE automobile field has always proved a magnet to the plastics industry and while in the past it has proved an erratic customer for some of our more adventurous efforts (we may instance here the complete plastic dash and instrument panel) yet the progress has been at an increasing rate and consumption of plastics on the average car in this country is stated now to be about 5 lb.; it covers many components: distributor heads, the usual electrical insulations, accumulator cases, draught extruders, small gears, lamp covers and reflectors, direction indicators, seat coverings, flexible jointing and dust covers, wheel grips and insignia, handles and knobs, and the smaller type of instrument "board." Behind the scenes there is also a growing market for the relatively small plastic tool.

That an entirely new picture of the motor car of the future is being built in the mind of some of the largest manufacturers was divulged in a remarkable lecture delivered before the Plastics Institute last month in London. Mr. R. Rajan, Senior Production Development Engineer to the British Motor Corporation, gave an enlightening and factual analysis of the present problems in motor manufacture, and indicated the broad lines on which he anticipated plastics would come into the picture.

Some facts he gave illustrate why car manufacturers are not dis-inclined to contemplate a gradual bias to plastics. For every ton of steel put into a car, one ton is wasted, unavoidably. For every gallon of paint applied, one is wasted and very costly plant is involved in removing this waste material. Thus if only for these reasons B.M.C. would like to increase the 5 lb. of plastic at present employed to more than 500 lb. It needs no effort to realize that Mr. Rajan implies the coming of the plastic body.

At the moment the U.K. makes roughly 1,000,000 cars a year, and Mr. Rajan suggested that a market for some 250,000 tons of plastics per annum was waiting. This, he argued, was worthy of an all-out effort by the plastics industry to produce material modifications and techniques to meet the requirements.

We agree, but we also understand the basic problem involved, for to every moulding organization, large or small, the problem is posed sooner or later of whether to accept or turn down a contract because of its sheer size. Acceptance would involve the commitment of so much of the production capacity to one customer that the danger of too many eggs in one basket would be paramount. It is a truth that some moulding companies have done just this, and in consequence the management have lost control, subjugated entirely to the dictates of the customer.

Against this background, it is hardly surprising therefore that plastics moulders have been cautious in their approach to the automobile industry, which they have long recognized as one

of their biggest potential customers. Our moulders will be hard put to commit the necessary proportion of their productive capacity to even nibble at the market. In fact nibbling would probably be quite uneconomic. It is therefore a question of plant investment, new buildings, capital expenditure. Where is the money to come from to stage the tremendous effort required ?

We obviously cannot expect special considerations in this competitive age. If we want this market, or some of it, we must go part of the way as far as the risks are concerned. However, we understand that one major motor company, realizing the problem, has initiated a policy that could do much to allay the latent fears of the moulder in this respect. The principle is to offer an exclusive manufacturing concession for 18 months for a component, in return for which the moulder undertakes not to make this component available to another motor company. The argument is that in 18 months the moulder should have so mastered the project as to be free from any fear of competition.

One doubt arises in our minds since bodies complete as panels, are involved. How would the established body-builders react ? So far as we know, no moulder within the plastic industry as we know it, has ever made a commercial vehicle body, other than as experiment, nor has any made a boat. The jobs have been carried out within existing industries. In grasping the prize we shall have to grasp a nettle or two as well.

Re-assessment

THE glass fibre/resin reinforcement industry still remains an economic and technical problem of considerable stature but at least some of the air of battle has cleared. More than ever have our own protestations against the permitted methods of practice of the so-called simple lay-up process and indeed of the short-comings of the process itself, proved to have been sound. What is more important, the self-styled technologist and the " do it yourself " campaigner no longer raises his voice to accuse us of " deliberate sabotage " of a wonderful and growing industry. Few talk now of no pressures, no moulds and no expensive equipment and the future clearly lies in the properly laid-out and equipped factory using technical apparatus, efficient mixers, metal matched moulds and presses where necessary, or the use of pressure by other means. We should like to express our thanks to those individuals who have supported us in our campaign.

We therefore look forward to the next British Plastics Federation Convention on this subject which we understand will take place later in the year and which we are confident will show considerable advances over the past year. We have already described some of these, particularly of the work of British Moulded Plastics Ltd., in the production of refrigerator bodies and of the excellent work seen at the Boat Show.

We look forward, too, to hearing progress in the continuous production of components and sheets—perhaps we shall receive further details of the Bristol process, or the Filon process worked by British Industrial Plastics Ltd.—and of the new sheathing of boats carried out by the Leicester, Lovell Company methods. We are all also anxious to hear of evaluations of existing combination spraying machines, some of which have not proved over-successful so far.

MOULDING POWDER AND SHOT

If I can put my oar in the discussion of the future of the automobile and with Mr. Rajan's remarks on the loss of paint in the average steel-body painting shop, it is to point out that glass fibre resin bodies at present do not give the solution. That much-vaunted advantage claimed originally for self-coloured structures that needed no paint was exploded long ago. The white streaks of the glass shows through even on pigmenting the mixture. If the glass can be properly " wetted " with the resin I feel sure the glass makers can provide the answer—by colouring the glass itself. Heaven alone knows they can do it in lovely greens and reds and browns and blues of all shades. Obviously, too, it doesn't pay to do so at the moment but it might prove an answer in the distant future.

Today's silly Thought

* * *

One dark night way back in early 1941 I was taking the air, such as it is near the gas-works not a 100 inches from Kew Bridge after dashing off my usual *opus magnus* on the country's folly in failing to develop a petrochemical industry when the usual evening concert of big base drum and euphonium started. I dodged down an alley-way past " The Jolly Bargee " to get to the canal bank and its occasional open spaces and settled myself against some stacked steel drums. There's nothing more comforting in a bomb-attack than to have a steel drum at your back and front. It was comforting that night because the big concrete flour store on the other side was blown up and burning merrily. I sat back, smoked a few cigarettes and then went home. Next day, out of curiosity, I went back. There were thousands of these drums—tens of thousands of them at the spot and in almost every back yard and derelict shack that could hold them. All were stamped with names of petroleum companies and chemical works and the letters U.S.A., and bolder than these was the same name on each one—sec. butyl alcohol. Since not one single drop of this solvent was then made in this country it all had to be brought over in ships some 3,000 miles and, although its not the thing to mention it now, at the cost of precious lives. Well, this nonsense is now changed for ever I hope, for us and for Europe, and you can, you *must* read for your own edification the important article published on pages 145 to 148, the new situation as it exists today. All this story to tell you why I'm now so allergic to steel, especially to steel barrels that contain solvents with a flash-point of 77° F.

Down at "The Jolly Bargee"

* * *

The bar-counter front in the King's Arms in Peckham Rye, S.E.15, has a Warerite pictorial panel incorporating a photographed one-fifth scale drawing of a fossil found on the local archæological site. Joe the lorry-driver who does the Southampton and Plymouth run, looks at it out of the corner of his eye, swallows hard and says " Two pints o' mild, please, miss." He turns to his mate. " Perce," he says, " look at this 'ere. Might be yer own grandad when 'e was laid aht flat." Perce lifts his pint and calmly and slowly empties it with one long vacuum pump-like action. " Joe," he says, " I've tole yer before; yer higgerant, that's wot yer are. It's a fossil that's wot it is. Ichthyosaurus Platydon to yew. Knocked abaht the Woolwich beds which was also the Thames in them there days, somethink like 70 million to 140 million years ago. Wot we nah call the Cretaceous Hera. It was a marine reptile if yer like, somethink like a shark but 'e didn't 'ave no fins. 'E 'ad feet all right and toes and a narsty turned-dahn beak. Two more pints please, miss." Joe sighs and says " Well, yer may be right, but I still say 'e looks like yer grandpa when 'e was laid aht flat."

Old Man River

DOGSBODDY.

The New Diakons

One of the most important developments in recent months has been the announcement by I.C.I.'s Plastics Division of the new grades of Diakon. In this report the situation is reviewed with special reference to the new markets opened up to these materials, and methods of fabricating them.

AMONG the ever-growing family of thermoplastic materials, polymethyl methacrylate is still outstanding for its unique resistance to ageing and weathering. These and its other good properties are best known through the deserved popularity of Perspex acrylic sheet. Worthy of mention are its clarity in the natural form, purity of colour in pigmented form, surface lustre, " feel," toughness, dimensional stability and heat resistance. That similar properties are available in the moulding powder versions may not be so widely known although such materials have been in use for over 20 years. Whereas British industry rapidly took to the shaping and fabrication of Perspex sheet resulting in the present large scale activities in this field the use of Diakon for moulding has grown much more slowly. Developments in the use of Diakon for moulding and extrusion are likely to accelerate as a result of intensive development work in recent years both in materials and fabricating equipment.

Early grades of Diakon were difficult to mould and injection machines then available lacked the necessary pressure efficiency and temperature control facilities. Through the intervening years, revolutionary changes have taken place in the design of injection machines, and the " mouldability " of Diakon has been improved enormously by a series of manufacturing changes resulting from close collaboration between I.C.I. research chemists and moulding technologists.

Polymethyl methacrylates are amorphous materials which gradually soften on heating without passing through a true melting point. Their viscosity at elevated temperatures depends primarily on molecular weight and if this is high as in the case of Perspex sheet, the polymer never becomes really fluid. Perspex heated for shaping becomes soft and " rubbery "; any attempt to make it fluid by further heating results in depolymerization. In order to provide a version of the material for injection moulding, a polymer of lower molecular weight is required which does become fluid at elevated temperatures. However, research showed that whilst flow of methyl methacrylate polymers increases progressively with reduction of molecular weight, the general physical properties (tensile strength, impact strength, heat distortion temperature, etc.) degrade rapidly if the molecular weight is reduced below a certain critical value. Above this value, physical properties remain substantially independent of molecular weight. Having established this critical value, a polymerization reaction had to be developed to provide polymer of consistent molecular weight, safely on the upper side of this value. The small amounts of catalyst and other aids needed for polymerization control have to be of the utmost purity and must not degrade the natural crystal clarity of the polymer. The same stringent requirements hold for lubricant (to assist injection moulding performance) and plasticizing agents (in the general purpose grades).

The successful solution of these problems has been a triumph of industrial research and has resulted in a series of new Diakons of superb quality and excellent moulding performance. Modern injection machines, particularly the latest preplasticizer types, handle the materials without difficulty, thereby removing previous technical obstacles which tended to inhibit the exploitation of Diakon.

Diakon in a New Form

Perhaps the most outstanding advance lies in the fact that in addition to the standard Diakon compounds available in the form of pellets or chips, a new form of clear polymer is offered at substantially reduced price which should further extend fields of application. This material can be obtained in either the general purpose or heat resisting grades and is a fine powder consisting of tiny spheres of polymer of average diameter 0.004 in. Strange though this material may first appear to the injection moulder, it will be found to mould satisfactorily on most types of injection machine. Before discussing this development in detail, however, it may be appropriate to review some of the salient features of Diakon injection moulding.

Injection Moulding : General Considerations

Diakon materials reach a viscosity suitable for moulding in the temperature range 180° C. to 250° C. This refers to the melt temperature and not necessarily to the readings of cylinder control instruments. The viscosity reached, however, is not as low as that of other thermoplastic materials such as polythene or polystyrene, so all moulding conditions must be arranged to accommodate this feature. With conventional plunger type injection machines, a reasonably high injection pressure is needed, and a heating cylinder designed for good pressure transmission is an essential requirement. Given these conditions, the majority of moulds can be filled using temperatures up to 230° C. For moulds with longer flow paths and moulds with restricted gates, maximum flow is obtained by raising the melt temperature to the highest safe value. Good regulation of cylinder temperature is then required to prevent overshooting the danger limit. When this happens, it is immediately revealed by " splash marks " on the surface of mouldings. In the same connection, the material fed to the hopper must be as dry as possible as the presence of moisture causes similar splashing at lower working temperatures. Mould temperatures up to 50° C. to 60° C. assist flow into the cavities as also do generous sprues and runners. Gate sizes are largely determined by section thickness of the pieces being moulded.

The advent of preplasticizer type injection machines has been of inestimable value in the moulding of Diakon. With such machines, pressure for injection is applied directly to the melt thereby achieving maximum pressure transmission, and permitting much closer control of the pressure behaviour in the mould. The pressure in the mould when the gate freezes, is, of course, one of the major factors determining the quality of mouldings. These considerations apply to the moulding of all forms of Diakon.

Injection Moulding with the New Grades

Moulding of the new fine particle form requires a few additional comments. Generally speaking, the usual forms of volumetric feed mechanism fitted to commercial injection machines are unsuitable. The most convenient machine modification involves fitting a weigh feeding device of which at least two varieties are available in Britain. A reasonably small clearance between plunger and heating cylinder is preferable though surprisingly enough, no trouble has been experienced in this connection on the various standard machines that have so far been tried.

The Osborn weigh-feed attachment has proved very satisfactory in use and is manufactured by Fawcett-Finney Ltd., of Birmingham. The principle of operation lies in a very accurately made weighing beam on one end of which is a weight and on the other end a weigh-pan which holds the moulding powder. Automatic operation is controlled by make-and-break electrical contacts actuated by the beam.

In operation, a weight equivalent to the amount of powder

required for a specific moulding is set to a scale on the weight cradle. Powder is fed from the hopper on to a vibrating tray actuated by an electric magnet. Vibration continues, passing the powder down a chute into the weigh-pan, until the pre-set amount has been delivered. At this point the balance of the beam breaks an electrical contact, stopping the vibration and thus the delivery of the powder.

The next stage is initiated by the movement of the die plate which, via a limit switch and a continuously running fractional horse-power motor, opens a flap at the base of the weigh-pan and drops the weighed charge into the feed cavity ready for the injection stroke. When the powder is discharged the beam returns to the horizontal position, thus reinitiating the cycle.

Pre-Plasticizing Machines

Pre-plasticizing machines such as the Windsor " Autoplas " twin screw type, or PECO " In-Line " plunger type, deserve special mention for use with this form of Diakon. The material is accepted by both without modification and injection takes place by displacement of the melt facilitating precise control of shot weight. No alteration of feed setting is required for mixtures of polymer and re-work. Coloured mouldings from Diakon polymer are conveniently produced on these machines by using dry tumbled blends of polymer and pigment. This subject is discussed later.

Mould Design

The general considerations of good mould design apply to Diakon polymer as much as to all materials, i.e. orientating the cavities, arranging for escape of air (venting), adequate ejection facilities, etc. There are a few special points, however, which experience at Welwyn has shown to be worthy of special mention.

Mould cavities must be slightly oversize to accommodate the inherent shrinkage which occurs to the extent of 0.004–0.008 in./in. (or cm./cm.). The exact shrinkage for any particular moulding can be found only by experiment.

To aid the flow of the material, large well polished sprues and runners are preferable, gating into the thickest part of the moulding. The size of gate depends upon the section thickness ; large round or rectangular gates are ideal for thick sections, whilst fan and restricted gates can be used for thinner sections. For general purpose grades of compound and polymer, pin-point gates can be employed to minimize finishing. For optical components and transparent decorative parts, tab-gating will frequently yield mouldings with minimum strain and least surface imperfections.

It is very desirable that all moulds used for Diakon should be cored for circulation of constant temperature fluid or, if this is impracticable, temperature control should be ensured by electrical heating.

Handling Precautions

Like all plastics which are good electrical insulators, Diakon readily picks up dust by electrostatic attraction, so cleanliness is essential to preserve clarity and purity of colour. As Diakon is not compatible with other moulding materials, rigorous precautions should be taken to prevent contamination. Finally, although water is harmless to Diakon mouldings, it does affect the moulding behaviour of all acrylics including Diakon. It should therefore be moulded in as dry a state as possible, the drier the material, the greater being the latitude in moulding conditions.

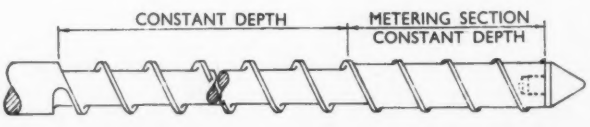


Fig. 1 (Above). Typical screw for extruding Diakon. Fig. 3 (Right). Shaping and cooling jig developed for extruding reeded trough section.

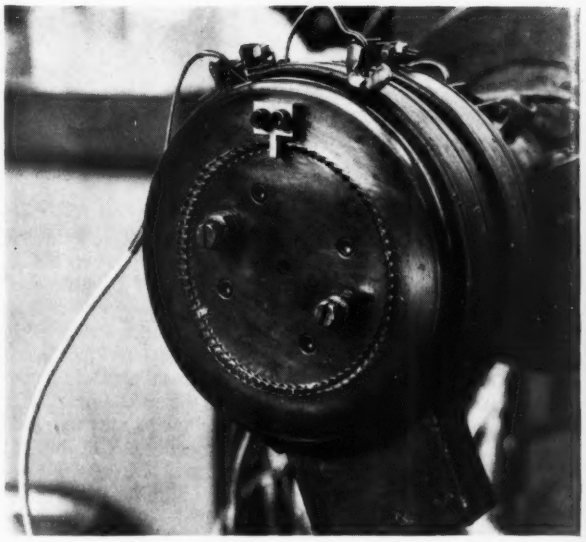


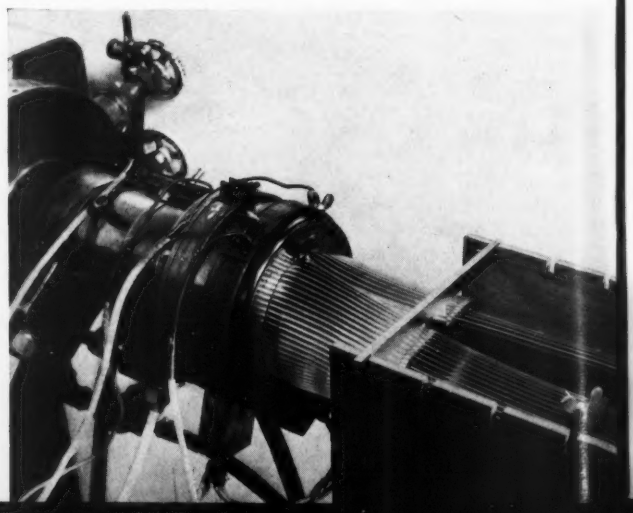
Fig. 2. Close-up of die-head developed at Welwyn showing slitting knife.

Diakon compound loaded on trays to a depth not exceeding 2 in., can be redried if necessary in an air-circulating oven, for example of the Mitchell type. A drying period of about four hours at 75° C. for the heat-resistant grades and 65° C. for the general purpose grades should be adequate. Additional precautions are necessary in redrying Diakon polymer in this type of oven because of the fineness of its particle size. To prevent the particles circulating in the oven atmosphere, it is recommended that the material be protected by stretching a tailored fabric cover (e.g. nylon) over the exposed surface.

Dry Colouring

Diakon polymer is readily dry coloured by virtue of its fine particle size. The equipment required is the normal end-over-end drum tumbling unit with adequate speed control. Certain colourants tend to agglomerate during storage, and the addition to the mix of earthenware balls of the type used in ball mills will overcome this. Care should be taken to avoid overloading with balls, which can lead to colourant degradation, as can prolonged tumbling time.

The standard of colouration of finished mouldings depends to a large extent upon the turbulence induced in the plasticized material in the injection machine. As noted earlier, the twin-screw pre-plasticizer machines provide excellent mixing and colourant dispersion. In the case of machines with separate



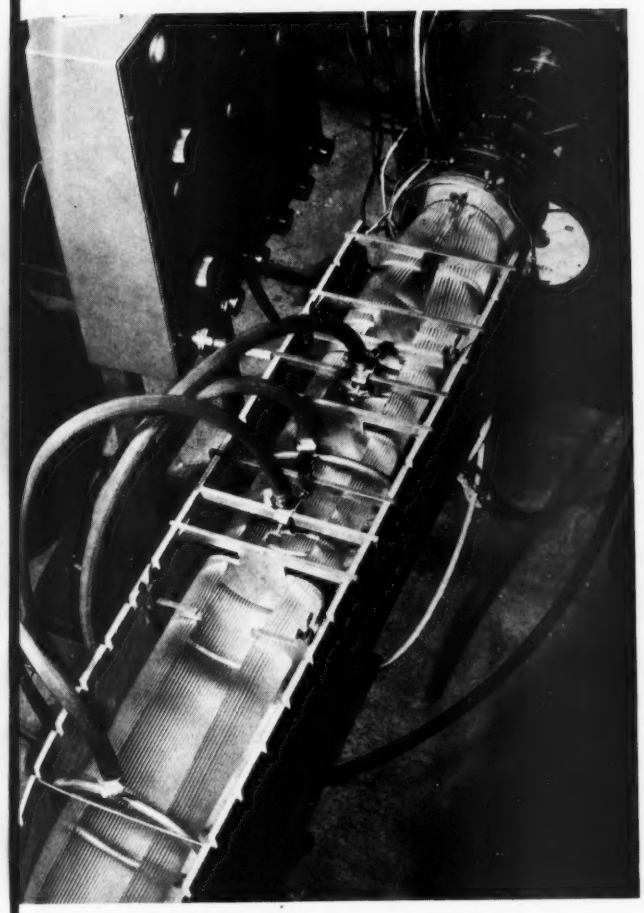


Fig. 4. View of extruded section passing through cooling system.

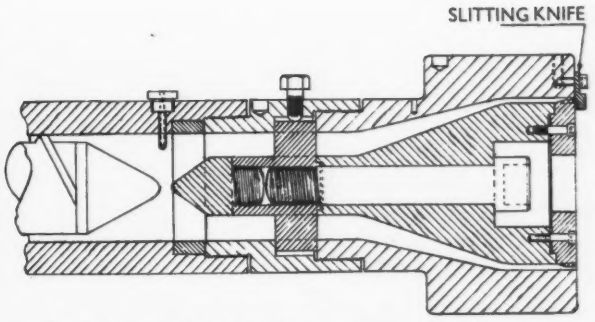


Fig. 5. Cross section of die for extruding reeded tubing section.

plasticizing chamber and pressure pot, such as the Peco type, considerable mixing is obtained with equivalent excellent results in the moulding. With conventional plunger type machines, little turbulence is induced in the barrel, and it is therefore necessary to employ either restricted gates or, where this is impossible, a strainer plate in the injection nozzle. The design of the latter requires care to avoid loss of pressure which, in the case of Diakon, would give rise to serious difficulties.

Extrusion

Successful extrusion of Diakon is a relatively recent development and opens up many possibilities for tubes, rods, sheets and profiles.

In an extruder barrel, material is heated both by conduction from the wall and by frictional energy developed from the shearing action of the screw. Bearing in mind the sensitivity of acrylics to overheating (symptom in this case being bubbles in the extrudate), successful extrusion of Diakon requires attention to certain features of the equipment.

Extrusion Equipment

Diakon is fed to the extruder in the form of rigid particles which on heating soften to a "melt" of high viscosity, thus calling for a machine of rugged construction with ample power input and adequate load carrying capacity.

Although considerable heat can be generated by the shearing action of the material in the barrel, Diakon, in common with all acrylic injection and extrusion materials, can withstand only a limited degree of heating before degradation with accompanying evolution of volatiles occurs. Suitable screws, running at relatively low speeds, are therefore recommended.

The extruder should have continuously variable speed control over a low range of screw speeds, and a long barrel (16 : 1–20 : 1) to provide a greater area of heat transfer to facilitate softening of the material. The temperature of each heating zone should be controlled accurately and as a further safeguard against overheating, each zone should be provided with cooling facilities. An additional refinement is the use of vented barrels for the extraction of unwanted volatiles.

Fig. 1 illustrates a screw that has been found satisfactory, having a single start, constant pitch, the pitch being about 1xD. The last four flights are of constant depth. Compression ratios in the range of 3 : 1–4 : 1 have been found satisfactory.

Die

To obtain a good surface finish on Diakon extrudates, all internal surfaces of dies should be highly polished. Chromium-

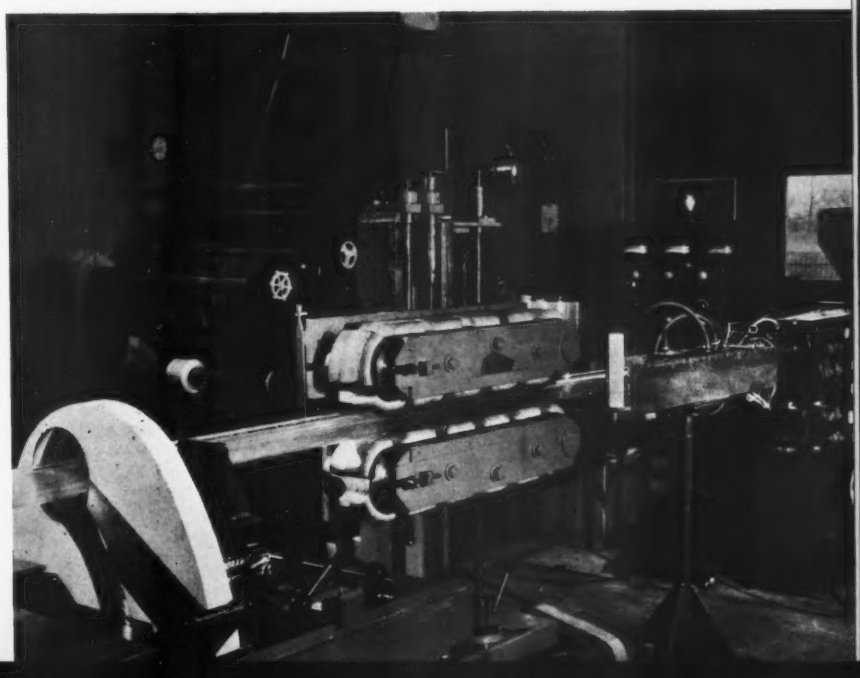


Fig. 6. Haul-off unit and travelling saw for the trough section.

Fig. 7. Stop and tail lights moulded in Diakon by Joseph Lucas Ltd.

plating is an additional benefit. All channels through which the " melt " passes should be shaped to prevent material hold-up and any unavoidable obstructions such as spider legs should be of streamlined shape. Uniform heating of the die is required and the temperature should be accurately regulated. For tubes and hollow profiles, a land length of approximately 12 times the section of thickness is generally used.

Haul-off and Finishing

Profile extrusion of rigid extrusion materials like Diakon may be regarded as a continuous moulding process. The process cannot usually have the positive control of a discontinuous system such as injection moulding where the shape is imposed and retained during cooling. Nevertheless, remarkable results can be achieved by the exercise of ingenuity.

The function of the finishing gear is to carry the extrudate from the die at a constant rate and to provide support for it whilst slow uniform cooling takes place. Minimum draw-down must be used to achieve freedom from stress. Cold water cooling should also be avoided with Diakon as this invariably produces quenching stresses. Sizing dies and forming jigs must have minimum contact area with a Diakon extrudate to avoid dragging, jamming, or surface marking.

These principles are illustrated in the production of a Diakon reeded trough section for a fluorescent lighting fitting (see Figs. 2, 3 and 4). The equipment consists of a 2½ in. Peco extruder, a 4 in. diameter tube die with slitting knife, a shaping and cooling jig, a haul-off unit, and a travelling saw (Fig. 6). The die, shown diagrammatically in Fig. 5, is a tube die of conventional design with polished internal surfaces and minimum obstructions to the flow of material. The inner lip bolted to the mandrel has a reeded profile. For the production of open trough sections, a slitting knife is attached to the die face as shown in Fig. 2, and the slit tube is passed through a shaping and cooling jig, illustrated in Figs. 3 and 4. This takes the form of an open-ended box structure, the sides being used to support shaping formers and air-cooling rings. Best results have been obtained with the male and female formers placed alternately as shown, rather than in coplanar positions. The formers are machined from ¼ in. steel plate and the forming profiles are chamfered to minimize contact area with the extrudate. Internal and external perforated copper rings are used to promote uniform air-cooling of the extruded sections. Spacing of the steel formers and location of the cooling rings are determined largely by the linear rate of the extrusion. With this particular set-up, linear rates of 24 in. per minute have been achieved corresponding to output rates of 60 lb. per hour. Shown in the illustration (Fig. 6) is a Boston Marine caterpillar haul-off which is ideally suited for this type of work. It is capable of handling any profile and exerts the necessary powerful straight line pull. Diakon extrudates are conveniently cut into desired lengths by a circular saw mounted on a travelling carriage as shown.

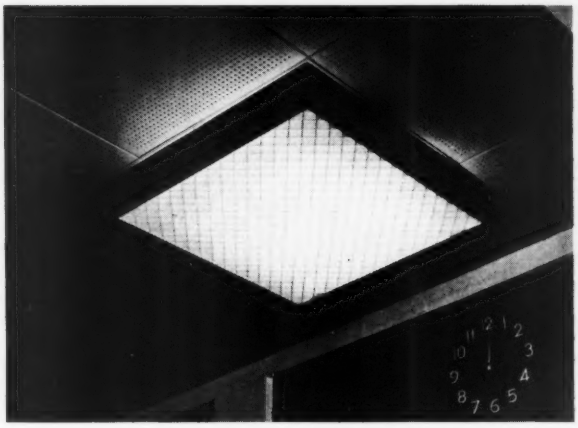


Fig. 9. Louvres moulded in Diakon.

Fig. 8. Fancy pin-box and trade insignia moulded by Wilmot Breedon Ltd.

Operating Conditions

Whereas extruded Diakon sections are virtually unaffected by humidity, moisture in the material prior to extrusion leads to considerable difficulty, usually manifesting itself in the form of bubbled extrudates. Diakon compound is best processed in a dry state, the drier the material, the greater being the latitude in the extrusion temperature range. A drying period of about

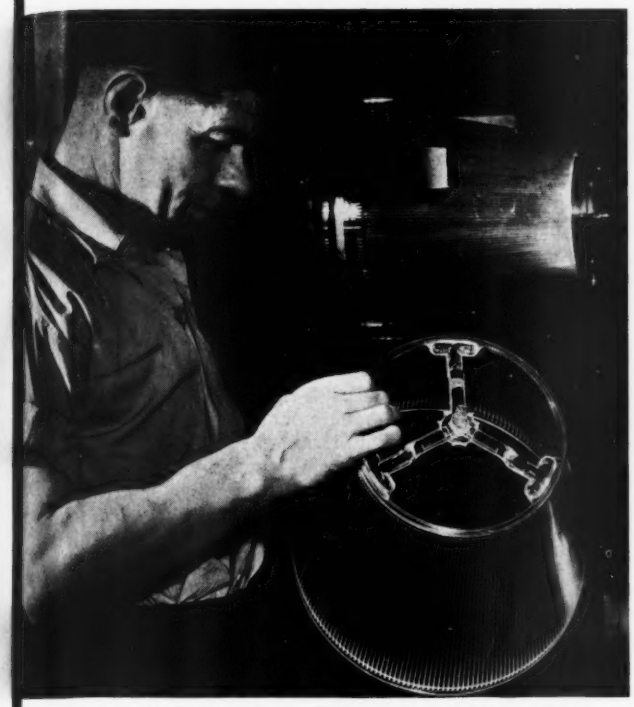


Fig. 10. Diakon light bowl manufactured by the Witton Moulded Insulation Works of the G.E.C.

eight hours at 75° C. in an air-circulating oven should be sufficient with material loaded on drying trays to a depth not exceeding 2 in.

The utmost cleanliness of drying cabinet and extruder is required to get the best results from Diakon since the slightest contamination shows up in the finished product. Optimum

PROPERTIES OF DIAKON MOULDINGS
GENERAL AND MECHANICAL PROPERTIES

Property		Test Method
Tensile strength ... ... lb./sq. in.	8,000–9,500	ASTM D–638
kg./sq. cm.	560–665	
Ultimate fibre stress in bend ... lb./sq. in.	12,000–19,000	B.S. 771
kg./sq. cm.	840–1,330	
Young's modulus in bend ... ... lb./sq. in.	$3.8–4.5 \times 10^5$	B.S. 771
kg./sq. cm.	$26.6–31.5 \times 10^3$	
Impact strength ... ... ft. lb.	0.25–0.40	B.S. 771
kg.m.	0.035–0.056	
Water absorption % 24 hours at 20° C. (68° F.) ...	0.4	ASTM D–570
Pyramid hardness	17.2	—
Vicat softening point ... ... ° C.	85–87	—
° F.	185–189	
Specific gravity	1.19	—
Mould shrinkage ... ... in./in., cm./cm.	0.004–0.008	—
Weight per cubic inch moulded ... ... oz.	0.685	—
gm.	19.44	
Compression ratio	1.8–2.2	—
Flammability ... ... in./min.	1.2	ASTM D–635

temperatures for the barrel and die can be found only by experiment, and once found, these conditions must be constantly held to maintain a consistent product.

Applications

Diakon materials have already found wide application in many fields. The new grades are expected to reinforce these applications, and in addition to open up a host of new outlets, partly in view of the lower price per pound of the polymer grades, and

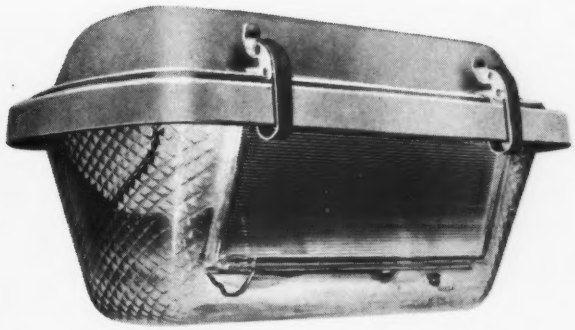


Fig. 11. G.E.C. lantern moulded in Diakon.

partly by virtue of the new markets open to the extrusion grades.

The major applications at the moment lie in the motor industry, where Diakon is fully established for such components as reflex reflectors, rear lamp housings, instrument dials, and medallions. Here the optical properties of the transparent grades, coupled with the inherent dimensional stability and excellent weathering characteristics, are utilized to the full. Examples are seen in Figs. 7 and 8.

These outlets are closely followed by the telephone and lighting industries. In the former, Diakon may well make a further significant contribution to the production of telephone mouldings, to meet the popular demand for coloured instruments. In the lighting sphere, Figs. 9, 10, 11 and 12, illustrate recent development most clearly. In addition to the side-street lighting units now moulded in Diakon, one company is proposing to injection mould the large " A " road lanterns, formerly low-pressure moulded in Perspex sheet. Extruded sections are also finding important applications in the lighting field as diffusers.

Apart from the very large scale outlets noted above, Diakon is moving rapidly into such items as radio scales, watch crystals, speedometer dials, and similar components. It is also expanding in such outlets as three dimensional insignia and medallions. The availability of clear Diakon in the cheaper polymer form opens up the prospect of extending these applications.

Finally, Diakon's hold on such outlets as shaver cases, fountain pen barrels, knife handles, cigarette holders, typewriter keys, cosmetic containers and buttons will be strengthened by the new grades. Toughness, surface lustre, purity of colour, " feel ", dimensional stability and optical clarity are amongst the characteristics that presage for Diakon a bright future.

Fig. 12. " A " road lighting unit moulded by G.E.C.

Polycarbonate Resins

By R. J. THOMPSON and K. B. GOLDBLUM*

The following article has been prepared for "Plastics" by the General Electric Co. of America and describes the manufacture, fabricating techniques, and suggested applications for their Lexan polycarbonate resins. G.E.C. materials are not obtainable in the U.K. but readers will find this factual report a most valuable reference for the future.

IN this day of innovations, it takes an exceptional material to register any impact on an industry which is growing as rapidly as the plastics business. Lexan moulding compound promises to be such a product. Lexan is the name chosen by the General Electric Company of America as a trademark for its new polycarbonate resin. It is a thermoplastic polymer which makes an excellent injection or extrusion moulding compound. But why has this newcomer aroused so much interest in the plastics field ?

Lexan moulding compound offers a unique combination of useful properties unmatched by any other thermoplastic product. These four outstanding properties are combined in this new material.

(1) **High impact strength**—over 12 ft. lb. per in. of notch.
(2) **Excellent dimensional stability**—low water absorption and 138° C. to 143° C. heat distortion point minimize dimensional changes.
(3) **Superior heat resistance**—shows excellent resistance to thermal-oxidative degradation at temperatures up to 149° C.
(4) **Good electrical properties.**

It is not offered as a replacement for any particular plastic product, but rather as a versatile raw material which can open up new applications and designs, and generally extend the range of usefulness of thermoplastic resins.

Polycarbonate resin also introduces an entirely new composition to the thermoplastic family. The polycarbonate name is taken from the carbonate linkage which joins the organic units in the polymer. This is the first commercially useful thermoplastic material with the carbonate radical as an integral part of the main polymer chain.

In the following sections, a closer look at the technology of Lexan moulding compound and how it can be made and fabricated are presented.

Manufacture of Polycarbonate Resins

The aromatic polycarbonates can be readily manufactured by one of two general methods:

(1) Ester exchange or fusion cook.
(2) Phosgenation.

The synthesis using the ester exchange method involves the interaction of a carbonate diester and a dihydroxy aromatic compound. In the case of Lexan polycarbonate resin, diphenyl carbonate and bisphenol A (2,2 bis [4-hydroxy phenyl] propane) are reacted together according to this equation.

$$(C_6H_5O)_2CO + HOC_6H_4C(CH_3)_2C_6H_4OH \longrightarrow$$

$$C_6H_5O\left[-C_6H_4C(CH_3)_2\,C_6H_4OCO-\right]_n-C_6H_5 + C_6H_5OH$$

The reaction mixture is held at 200° C. to 230° C. and 20 mm. to 30 mm. Hg. pressure until 80% to 90% of the phenol of condensation has been removed. At this point the temperature is raised to 290° C. to 300° C. and the pressure is reduced to below 1 mm. Hg. As the reaction proceeds, the melt viscosity increases and the molecular weight grows. The resin can be removed from the reaction vessel by extrusion under inert gas pressure.

Because of the equipment limitations imposed by the high melt viscosity, only polymers of limited molecular weight can be made by the fusion method in stirred kettles. However, further reaction can be carried on using vacuum rolls by which resins of higher melt viscosities have been prepared. For example, resins of intrinsic viscosity (as measured in p-dioxane at 30° C.) in the range of 0.6–0.7 have been made regularly in stirred kettle reactions. The use of vacuum rolls has made possible the preparation of resins with intrinsic viscosity greater than 1.5.

Experimental work has indicated that an initial excess of the carbonate ester is desirable both from the stability and from the volatility points of view. With regard to stability, the excess of ester insures the more rapid and complete reaction of the bisphenol which may decompose if held above 180° C. unless esterified. The volatility of diphenyl carbonate compared to that of the bisphenol facilitates the removal of this ester and allows the reaction to proceed more readily.

Among the variations possible in the fusion cook method is the use of a monomeric biscarbonate ester of the bisphenol which upon condensing with itself by splitting out a simple carbonate ester forms a polymeric molecule. Catalysts can be used. Basic catalysts are much more effective than acid catalysts. The equipment must be quite leakproof since a small leak which allows air to pass through the very hot reaction melt will give a crosslinked, thoroughly useless product.

Phosgenation, in which the carbonate linkage is introduced by means of phosgene, is the basis of the other general method used. This scheme has at least three variations which are worthy of discussion:

(1) All-pyridine system.
(2) Partial pyridine system.
(3) Aqueous—inert solvent system.

It is obvious that as phosgene reacts with bisphenol A, hydrogen chloride is evolved as shown in the following equation:

$$n\,HOC_6H_4{-}C(CH_3)_2{-}C_6H_4OH + nCOCl_2 \longrightarrow$$

$$\left[-OC_6H_4C(CH_3)_2\,C_6H_4O\overset{O}{\overset{\|}{C}}-\right]_n + 2nHCl$$

The nature of the end groups, either H or Cl or a mixture of both, will depend on the ratios of the reactants.

In the all-pyridine system the pyridine functions as the hydrohalide acceptor, as the solvent and, in addition, possibly as a catalyst. When phosgene is bubbled into a stirred solution of the bisphenol in pyridine, a somewhat exothermic reaction occurs. At some point in the reaction, which depends on the temperature of the reaction mixture, pyridine hydrochloride begins to crystallize out of the mixture. As the stoichiometric amount of phosgene is reached, the reaction mixture quite suddenly becomes very viscous. The polymer may be recovered by precipitation from the reaction mixture by a nonsolvent such as methanol or isopropanol.

The temperature of reaction, the concentration of the bisphenol, the rate of addition of phosgene, the purity of the bisphenol, the amount of water and impurities in the pyridine have a greater or lesser effect on the molecular weight attainable by this system. Reactant purity is probably the most important variable, consequently much time and effort have been spent in determining the degree of purity necessary.

The main difference between the all-pyridine and the partial pyridine systems is the replacement of that part of the pyridine which has a solvent function with a lower cost solvent in order to make the process more economical. Solvents for the polymer which have been used successfully are: benzene, toluene, chlorobenzene, dioxane, methylene chloride, and trichlorethylene. The

* General Electric Co. of America.

pyridine has been retained solely as a hydrohalide acceptor. Other tertiary amines have also been used.

The partial pyridine reaction is carried out very similarly to the all-pyridine reaction described above. The amount of pyridine can be varied from the stoichiometric ratio on up. The control of molecular weight can be achieved by the control of the same variables described above. Care must be taken in the use of the variables to control the molecular weight since interaction has been found between them in some cases. Special care must be exercised to wash out all of the pyridine and pyridine hydrochloride from the reaction mixture so that the final precipitated polymer will not be contaminated.

The aqueous inert solvent system differs from the partial pyridine system in that the pyridine is replaced as a hydrohalide acceptor by an aqueous caustic solution. Good mixing is essential in this scheme because the hydrophobic and hydrophilic portions of the two-phase system must come into intimate contact for good reaction. Quarternary ammonium salts, such as trimethyl benzyl ammonium chloride, act as catalysts in this system for obtaining high molecular weight products. The complete removal of sodium from the polymer seems essential to its stability on ageing at elevated temperatures.

Since the polymer is obtained in solution, it must be precipitated or otherwise recovered, as in the other solution systems. The recovered, dried polymer can be densified for further operations, by extrusion and chopping, or cold pressing into pellets.

The advantages and disadvantages of each system can be readily seen by referring to the following table:

MANUFACTURING SYSTEM

Ester Exchange	All-Pyridine	Partial Pyridine	Aqueous Inert Solvent
ADVANTAGES—			
(1) No solvents.	(1) No molecular weight limitation.	(1) No molecular weight limitation.	(1) No molecular weight limitation.
(2) No solvent recovery.	(2) Run under moderate conditions.	(2) Run under moderate conditions.	(2) Run under moderate conditions.
(3) Resin obtained in densified form.	(3) Simple equipment.	(3) Simple equipment.	(3) Simple equipment.
		(4) Lower cost solvents.	(4) No costly solvents.
DISADVANTAGES—			
(1) Equipment limitations.	(1) Pyridine costly as solvent.	(1) Solvent recovery system needed.	(1) Solvent recovery system needed.
(2) More difficult to get high molecular weights.	(2) Very efficient solvent recovery necessary.	(2) At least three solvents must be recovered.	(2) At least two solvents must be recovered.
(3) High temperature and high vacuum with leak-proof operation necessary.	(3) Polymer must be purified.	(3) Polymer must be purified.	(3) Polymer must be purified.
	(4) Polymer must be densified.	(4) Polymer must be densified.	(4) Polymer must be densified.

Each of the systems has its own inherent advantages and disadvantages. The ultimate choice in any particular case will have to rest on a complete study of each process and the economic considerations involved.

Fabrication of Aromatic Polycarbonate Resins

The aromatic polycarbonate resins have been fabricated by virtually every method and technique used in thermoplastic technology. The densification of the polymer particles from the manufacturing step by extrusion and chopping has been referred to above. Further, the polymer may be injection, transfer or compression moulded; cast, flat or blow extruded into films or sheets; vacuum formed; spun into fibres; applied to surfaces from solution or by fluid bed techniques. The films are heat sealable. Parts may be welded with a hot air torch or cemented with solvents. The excellent machinability of Lexan parts has been demonstrated in practically every machining operation.

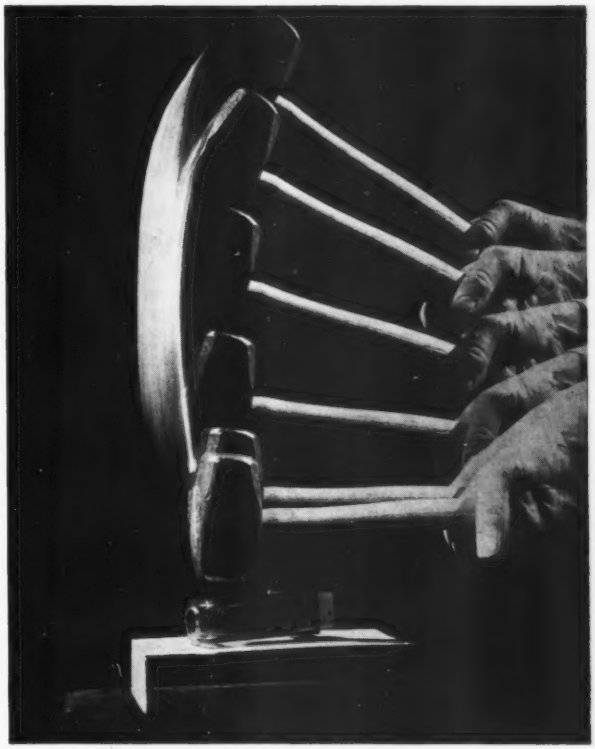


Fig. 1. A graphic photograph demonstrating the high impact strength of Lexan.

Injection Moulding

Since the first product objective in the Lexan polycarbonate resin development has been an injection moulding compound, most work has been done in the injection field. The cylinder temperatures for injection are in the 260° C. to 302° C. range. However, because of the excellent thermal stability of the resin, temperatures as high as 371° C. have been successfully used. Due to the high melt viscosity of the polymer, about 4×10^3 poises at 572° C., it is suggested that the maximum pressure of the injection machine be used. Short mould filling times are preferred so that freezing off in the runners and at the gates is minimized. Gate size is somewhat open to debate. In many cases, a larger gate has been used to get good parts but, in others, quite small and restricted gates have produced satisfactory mouldings. The lands should be as short as conveniently possible. The runners preferably should be large and full round. The sprue also should be large. A heated nozzle is preferred, but good mouldings have been made with unheated nozzles. Moulds at room temperature have been used successfully in many cases, though more usually temperatures of 77° C. to 93° C. are recommended. Since Lexan resin moulding is affected by moisture which shows up as streaking, bubbling and poor physical properties, drying before moulding in shallow layers of not over 1 in. in depth at 110° C. to 125° C., preferably in dehumidified ovens, is suggested.

Extrusion

The experimental information on extrusion conditions indicates that temperatures of 232° C. to 288° C. can be used in the barrel. Water cooling of the screw is not recommended due to the high melt viscosity developed. Even more important than in injection moulding, the feed to the extruder must be as moisture-free as possible. The presence of moisture will be indicated by small bubbles in the body of the extruded shape.

If the moisture content is high enough, the extruded material will be foamy in appearance.

Only preliminary data are available with regard to the other methods of fabrication. However, enough has been done to indicate promise in products made by these methods.

Properties of Moulded Lexan Resin

(1) Physical Properties

The physical properties that have been collected to date are given in the following table. Unless otherwise indicated, the tests have been made at room conditions:

Test	Result	ASTM Test
Colour	Light amber	—
Specific gravity	1.20	D792
Odour	None	—
Taste	None	—
Refractive index at 25° C.	1.584	—
Rockwell hardness	M 70, R 118	D785
Abrasion resistance, Taber abraser with CS–17 wheel.	24 mg./1,000 cycles	D1044
Impact strength, notched Izod	12–16 ft. lb./in. notch	D256
Impact strength, unnotched Izod	>65 ft. lb./in.	D256
Tensile-impact*	600–900 ft. lb./cu. in.	—
Tensile yield strength	8,000–9,000 p.s.i.	D638
Tensile ultimate strength	9,000–10,500 p.s.i.	D638
Tensile modulus	320,000 p.s.i.	D638
Elongation	60% to 100%	D638
Compressive strength	11,000 p.s.i.	D695
Compressive modulus	241,000 p.s.i.	D695
Flexural strength	11,000–13,000 p.s.i.	D790
Flexural modulus	375,000 p.s.i.	D790
Shear yield strength	5,400 p.s.i.	D732
Shear ultimate strength	9,200 p.s.i.	D732
Light transmission	(4 in. diam. x $\frac{1}{8}$ in. thick disc) 58%	—
Light reflectance	(4 in. diam. x $\frac{1}{8}$ in. thick disc) 9%	—
Water vapour transmission	3–4 g./cm./hr./cm.²/mm. Hg. x 10^{-9}	—
Bulk factor of pellets	1.74	—
Nitrogen transmission	0.012 cc./mm./sec./cm.²/cm. Hg. x 10^{-8}	—

* " Tensile-Impact," C. G. Bragaw, *Modern Plastics*, page 199, June, 1956.

Coefficient of friction (unlubricated)	Low speed (1 cm./sec.)	High speed (173–202 cm./sec.)
Lexan on Lexan	0.24	ca. 2.0
Lexan on steel	0.73	0.82
Steel on Lexan	0.35	0.45

(2) Thermal Properties

Test	Result	ASTM Test
Heat distortion temperature	264 p.s.i. to 138° C. to 143° C.	D648
	66 p.s.i. to 140° C. to 145° C.	D648
Mould shrinkage	0.005–0.007 in./in.	D955
Thermal conductivity	4.6 x 10^{-4} cal./sec./cm.²/°C./cm.	—
Coefficient of linear thermal expansion	7 x 10^{-6} in./in. °C.	D696
Crystalline melting point	268° C.	—
Flammability	Self-extinguishing	D635
Shrinkage on ageing 2,000 hrs. at 125° C.	0.001 in./in.	—
Melt viscosity at 300° C.	4,000–6,000 poises	—

	Temp. ° C.	Load lb.	Deformation %	
Deformation under load on 0.5 in. cube	70	1,000	0.282	D621
	70	500	0.080	
	25	1,000	0.220	
	25	500	0.101	
Brittle temperature	— 135° C.			D746

(3) Electrical Properties

Temperature — ° C.	−30° C.	−3° C.	23° C.	100° C.	125° C.	ASTM Test
Dielectric constant 60 cycles	3.12	3.14	3.17	3.15	3.13	D150
10^6 cycles	—	—	2.96	—	—	D150
Power factor 60 cycles	0.005	0.004	0.0009	0.009	0.0011	D150
10^6 cycles	—	—	0.010	—	—	D150
Volume resistivity ohm–cm.	$>10^{17}$	$>10^{17}$	2.1×10^{16}	2.1×10^{15}	2.0×10^{14}	—
Arc resistance, stainless steel strip electrodes	—	—	10-11 sec.	—	—	D495
Dielectric strength short time, 25° C.	3,910 v./mil. at 1.5 mils. 3,080 " " 3.0 " 2,560 " " 4.7 " 1,130 " " 23.0 " 400* " " 125.0 "					D149
Dielectric strength short time, 100° C.	3,380 v./mil. at 3.0 mils. 1,250 " " 23.0 " 600* " " 125.0 "					
Resistance to electron beam radiation—	No change up to 50 Mr. dosage.					—

* The step-by-step values are essentially the same as the short time values for the 125 mil. pieces

(4) Chemical Properties

Water absorption, 24-hour immersion, 0.3%. ASTM test D570.

Stable to: Water, dilute mineral and organic acids, aliphatic hydrocarbons and alcohols.

Attacked and decomposed by: alkaline solutions, ammonia and amines.

Easily soluble in: chlorinated hydrocarbons.

Partially soluble in: aromatic hydrocarbons, ketones.

Resistant to: tea, coffee, grape juice, orange juice, tomato juice, catsup, tincture of iodine and merthiolate.

(5) Miscellaneous Properties

Outdoor exposure—one year at Pittsfield, Mass.—no change in appearance.

Exposure to G.E. sunlamp at 6 in. distance for six weeks—slight yellowing.

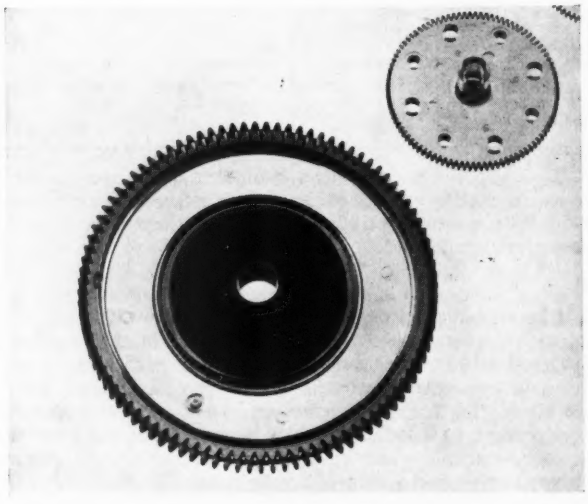


Fig. 2. Lexan has proved completely suitable for the moulding of gears.

Applications for Lexan Moulding Compound

If a plastics engineer were looking for an ideal plastic, impact strength would probably be a prime requirement. The fact that Lexan resin has exceptionally high impact strength suggests its use in applications where toughness is a requisite. Housings for business machines, communication equipment, and electrical apparatus fall in this category. The colourability of Lexan resin, its transparency and self-extinguishing rating enhance its suitability for such applications. Handles and structural parts may now gain the advantages of plastics and still retain strength.

Fig. 1 demonstrates the ability of a Lexan housing to absorb heavy hammer blows. Well-moulded Lexan parts will withstand sharp hammer blows and generally the parts will deform before eventually rupturing. An injection-moulded Lexan safety helmet did not break after repeated impacts of 68 ft. lb. in a falling ball test.

The dimensional stability of Lexan mouldings, especially when coupled with impact strength and heat resistance, opens up a variety of potential applications. A prospective customer checked a Lexan moulded part under a wide variety of temperature, humidity and environmental conditions, and reported that Lexan resin was the most dimensionally stable plastic he had ever tested. Many types of gears should benefit from the properties of Lexan resin. Gears for clocks, business machines, automobiles, appliances, and film projectors are possibilities for improvement with this moulding compound.

Perhaps the most important application for polycarbonate resin will be derived from the fact that it may replace a metal part assembled from several components. Either by re-designing or simply by moulding the assembly directly, a moulded part could offer a cost reduction and possibly improved performance. A part composed of a gear, pinion and shaft, made of three different materials and assembled, has been injection moulded in one piece with Lexan moulding compound. Die cast metal parts, especially those made from brass and zinc, look susceptible to replacement by Lexan resin. Fig. 2 contains an array of gears moulded of Lexan compound including complete assemblies as described above.

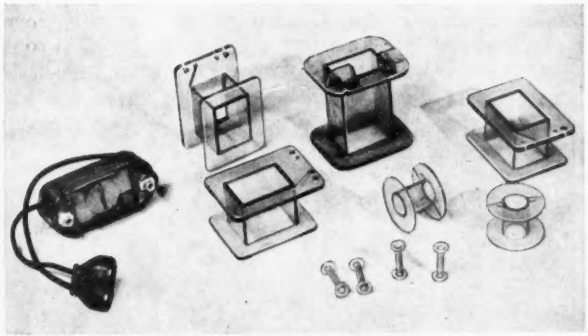
There is a growing need for plastics with higher heat resistance. Parts for electronic equipment, appliances, and heating apparatus must meet increasing temperature requirements. The combination of transparency and heat resistance suggests uses for Lexan resin in lenses and instrument windows where environmental or illumination heat call for high temperature stability. Lexan resin's superior heat resistance makes it suitable for these uses. In some cases, companies which were contemplating thermosetting resins to obtain necessary heat resistance in certain parts, are now considering the use of Lexan moulding compound which approaches thermosetting materials in heat distortion temperature.

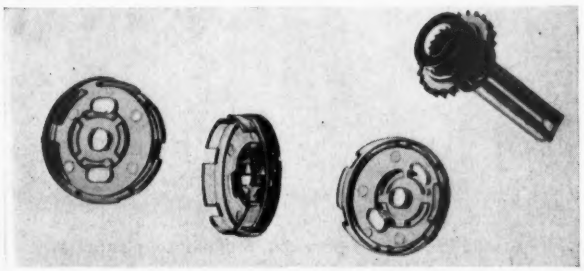
There is a trend toward smaller electrical equipment which usually results in increased operating temperatures. Polycarbonate resin's good electrical properties and high heat resistance should make possible its widespread use in the electrical field. Coil forms are a good example of parts which require toughness and heat resistance. An assortment of coil forms is shown in Fig. 3. The small coil forms at the bottom are about ½ in. long with a wall thickness of 20 mils. The coil at the left was put in the mould as an insert and encapsulated by injection moulding resin around it. Other electrical uses include wire insulation, structural parts, housings, and insulating parts.

An interesting application area for plastic materials is the use of Lexan resin for fabricating fasteners of various types. Such uses as grommets, rivets, nails, staples and nuts are under evaluation or have been proposed. The ability of Lexan parts to be cold-headed has excited considerable interest in rivet applications. Also, solutions of Lexan resin show promise as bonding or cementing agents in certain uses, and maintain their bond strength over a wide temperature range.

Small industrial parts of many types can be improved with the combination of the properties of this polycarbonate resin. Fig. 4 shows a variety of such parts. Cams, bearings, switches, levers, hardware, fittings, valves and bushings have been fabricated with this resin. Where many plastic materials can satisfy only one or two requirements of an industrial application, a polycarbonate resin frequently meets all of them.

This moulding compound is only one member of the polycarbonate family. As variations in properties are needed, other polycarbonate resins will probably be introduced. In addition to the moulding compound form, Lexan-type products show promise as film, fibres, and elastomers. This versatile new resin may lead to a complete family of plastic products, each offering desirable properties in its field.





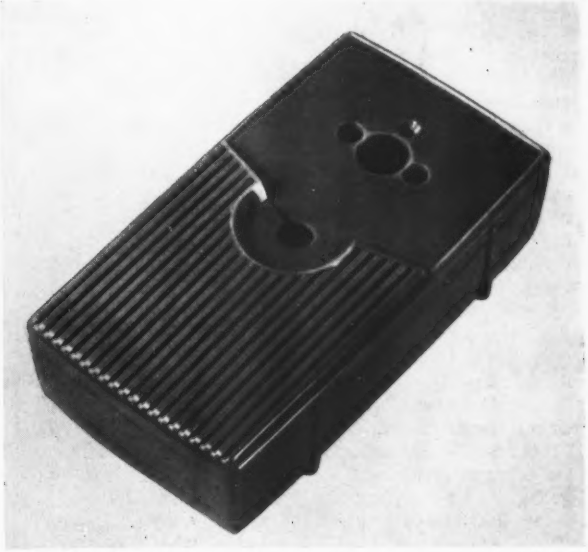


Fig. 3. (Top left.) Moulded coil forms and an encapsulated coil is shown on the left.

Fig. 4. (Left.) Cam mouldings.

Fig. 5. (Above.) Injection moulded radio cabinet in Lexan.

High Polymer Science and Technology in the United States — Part 2

By J. GLAZER,* Ph.D.

Continuing his commentary on the American scene, the author describes in this present instalment his visit to the Mellon Institute at Pittsburg, where a great deal of polymer research is carried on. The illustrations are by courtesy of the Mellon Institute.

ALL will agree that, in high polymer science at least, an enormous amount of first-rate fundamental work has been carried out in the research and development laboratories of private industry in the United States. In general, this work is in no sense inferior to that done in the Universities and Institutes of Technology and it is gratifying to note that in addition to these centres of research, there is an equally virile, intermediate type of organization that is contributing, as part of a wider scheme, to our knowledge of high polymer science. This is the privately endowed institute that exists in the United States where research is pursued having a wide spectrum of application to modern industry.

One such organization is the Mellon Institute at Pittsburgh whose newly-appointed Executive Director of Research is Dr. Paul J. Flory. Dr. Flory, who needs no introduction to high polymer scientists, is world renowned for his contributions to the thermodynamics of high polymer systems and the network theory of high elasticity. He was appointed to his present position some 18 months ago and now co-ordinates the work of his six research directors who, in turn, consider the suitability of specific research projects in the light of the available facilities and research trends of the Institute. The Mellon Institute is a privately endowed, non-profit making organization, established in 1913 by Andrew W. and Richard B. Mellon for the purpose of conducting fundamental and applied research in the natural sciences and for the training of research workers. A measure of its success in this capacity can be gauged from the fact that during the year ending March, 1957, more than $5 million were spent on research work at the Institute, and that in this period 60 research papers and 25 Patents were published. This work was performed by a research staff of approximately 500 qualified personnel aided by a service staff of over 200. Since its establishment, members of the Institute have been awarded over 200 Master's and Doctor's degrees by the University of Pittsburgh and it is significant that one of the research Fellowships has now been continuously operated for 45 years.

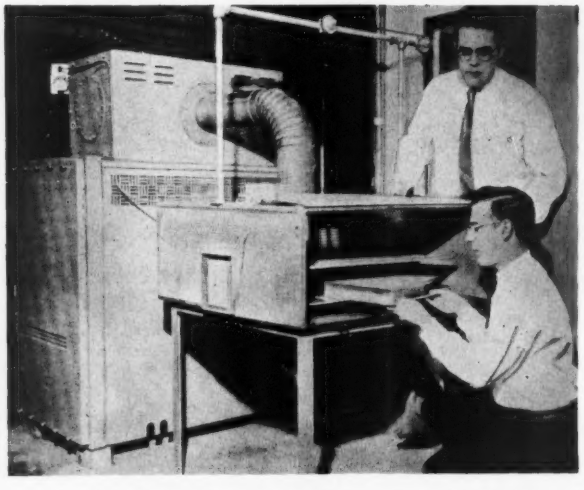
Although high polymer problems constitute only a part of the Institute's research activities, an organization of this size and type plays an important part in the scientific and technological life of the country, and it is instructive to review very briefly the extent to which high polymer systems are being studied at the Institute at the present time.

Elastomers

In Part I of this series, we noted how the U.S. Government's Rubber Reserve Co., by initiating and extending fundamental and applied research, played a determining role in achieving large scale production of synthetic rubber during World War II. These activities did not cease in 1945. They were maintained by the government, through its Reconstruction Finance Corporation, Office of Synthetic Rubber, over the period 1946–55, and during this time several research Fellowships were in operation at the Mellon Institute. These were "Multiple" research Fellowships each of which consisted of a research team containing up to 20 qualified personnel. These teams worked in conjunction with the various service departments of the Institute. One such Fellowship was established to study Synthetic Rubber Instrumentation and it resulted in the development of improved methods of control in the production of butadiene-styrene copolymers. In this way, higher production efficiency and improved products were obtained.

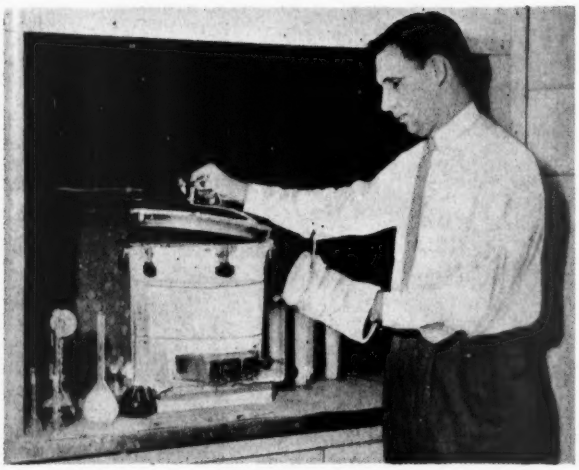
A second Multiple Fellowship was concerned with the correlation of physical properties of synthetic elastomers with their molecular constitution, and one of the facets of this investigation was the study of diene polymers (polybutadienes and polyisoprenes) by their infra-red absorption properties. This resulted in the rationalization of certain features of polydiene absorption spectra, and allowed the explicit determination of the proportion of 1 : 2, 1 : 4 and 3 : 4 addition that had occurred during polymerization. This had immediate practical application in that it was then possible to study the effects of pressure, temperature and catalyst variation during polymerization on the chemical constitution of the polymer. The road thus lay open to fundamental work directed towards a better understanding of the effect of chemical structure on processing and functional properties of the polymer. Even today, the repercussions of this excellent work are evident. All high polymer scientists and technologists are excited by the prospect of the ever-widening range of elastomers and thermoplasts now being developed by the use of stereospecific Ziegler-Natta catalysts and similar systems. And it is well to recall that these stereospecific elastomers (e.g. synthetic "natural" rubber and *cis*-1 : 4-polybutadiene) have been studied and are now being developed on a commercial scale with the aid of the infra-red work pioneered at the Mellon Institute. It is no accident that every research laboratory concerned with the development and production of these new types of rubber possesses at least one infra-red spectrometer.

A further illustration of the effectiveness of external sponsorship springs to mind in considering another investigation that has been carried out at the Institute. This was concerned with the tensile properties of elastomers. It has been known for some short time that the tensile strength of elastomers is, in some measure, dependent upon the degree of orientated crystallinity



A solid elastomer is produced from a p.v.c. plastisol by heating in a radio-frequency oven.

* Senior Lecturer in Polymer Chemistry, National College of Rubber Technology.



A p.v.c. plastisol under trial as a gasketing material.

present in the elongated elastomer at the moment of rupture. To determine more fully this relationship, it was necessary to develop reliable quantitative methods for assessing molecular orientation in the stretched elastomer. A precedent already existed in that natural rubber had been investigated somewhat earlier in Europe, using techniques based upon X-ray diffraction and optical birefringence. These powerful techniques had proved successful with natural rubber which was known to crystallize on stretching. However, it was left to American investigators—with their particular interest in synthetic elastomers—to explore the field of polybutadiene and silicone polymers, which do not crystallize on stretching at room temperature. This was done at the Mellon Institute as part of a research project sponsored by the Office of Synthetic Rubber.

With the aid of the Departments of Instrumentation and Chemical Physics of the Institute, the project Fellows developed and built a Geiger-counter apparatus with beam monitor and thermostating accessories for making accurate measurements of X-ray beam intensities, and it proved possible to detect and measure the existence of orientated crystallinity in polybutadiene at sub-zero temperatures. The same method is now being used in connection with a Fellowship of the Dow Corning Corporation for the investigation of silicone polymers, and it is to be hoped that this work, combined with the efforts of the Institute's organic chemists, will result in the development of new types of silicone polymers with enhanced strength properties. At the same time, studies have been undertaken with polybutadiene and its copolymers the purpose of which is to elucidate the dependence of tensile strength on the extent of cross-linking of the elastomer. Since these elastomers are completely amorphous at normal temperatures, a different approach is required from that suitable for the crystallizable elastomers, and theories have been proposed and are now being tested along the lines that tensile strength is a function of the amount of orientated (but not necessarily crystalline) elastomer at the break point. The amount of orientation will clearly depend upon the ultimate elongation of the elastomer and this, in turn, depends upon the degree of cross-linking. As is often true in other scientific investigations, fresh results suggest novel ideas and this study has been no exception in that recent work suggests that the flow properties of the elastomer are a contributing factor to the tensile strength properties. The incursion of rheological effects into this problem is welcomed by the Institute since it possesses an extremely active group of research workers who have, for some time, specialized in rheological studies of high polymer systems.

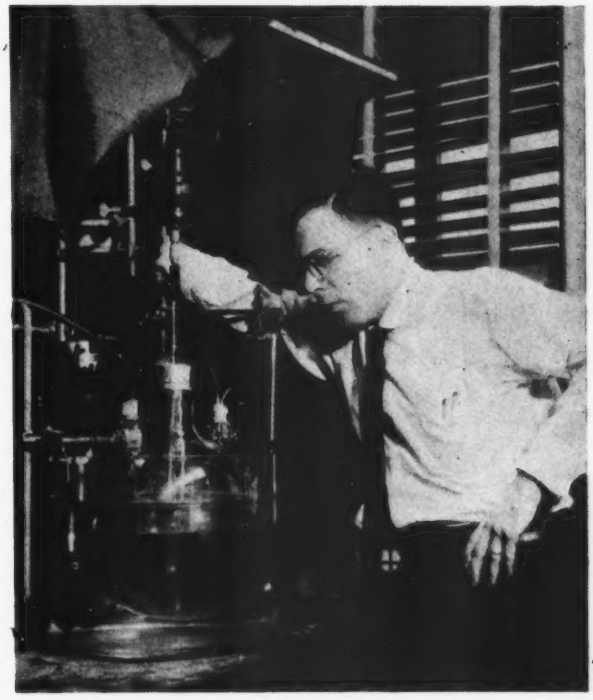
It was unfortunate, although perhaps understandable, that the government sponsored synthetic rubber Fellowships were wound up when the Industry was sold by the government to private concerns in 1955. However, the Institute has reacted characteristically by setting up a new Polymer Section in the Department of Research in Physical Chemistry and there is every reason to believe that this newly-created section will continue in the great tradition of its predecessors. At the present time, high polymer studies are being made with the support of a grant from the National Science Foundation and the personnel policy of the Polymer Section is to attract " pure " scientists so that fresh ideas and techniques may be brought to bear and be co-ordinated in high polymer problems.

Fibres and Resins

Multiple Fellowships by the Carbide & Carbon Chemicals Co. and the Bakelite Co. (both are divisions of the Union Carbide and Carbon Corporation) have been operated for some years now by two main groups of research workers, each consisting of approximately 20 qualified persons. Most of the recent developments in the field of synthetic fibres and resins are of such immediate commercial applicability that it is difficult to obtain comprehensive information. However, the scope of these Fellowships can be sufficiently indicated by the type of problem that is being attacked by these projects.

In a typical case, bonding resins have been developed which can be applied as coatings to a substrate without destroying the original surface properties of the substrate. Thus, briquets may be bonded in such a way that the sorption properties of the substrate remain effective and rigid masses of activated carbon, alumina and silica gel can be formed and used for odour and moisture absorption as well as gas and liquid filtration. One result has been the development of filters made of paper coated with activated carbon for use in high velocity air-conditioning plants.

The development of resins for the treatment of textiles so as to improve shrink and crease resistance is being actively pursued and studies have been made in the sizing of glass fibres with amineal-dehyde resins. In this connection, it is interesting to note that the Institute possesses a large Multiple Fellowship, sponsored by the Pittsburgh Plate Glass Co., employing over 20 scientists in fundamental studies on glass science. Glass is, of course, a high polymer in its own right and has many fundamental features common to organic high polymers, especially at low temperatures. However, the increasing popularity of glass fibre in the



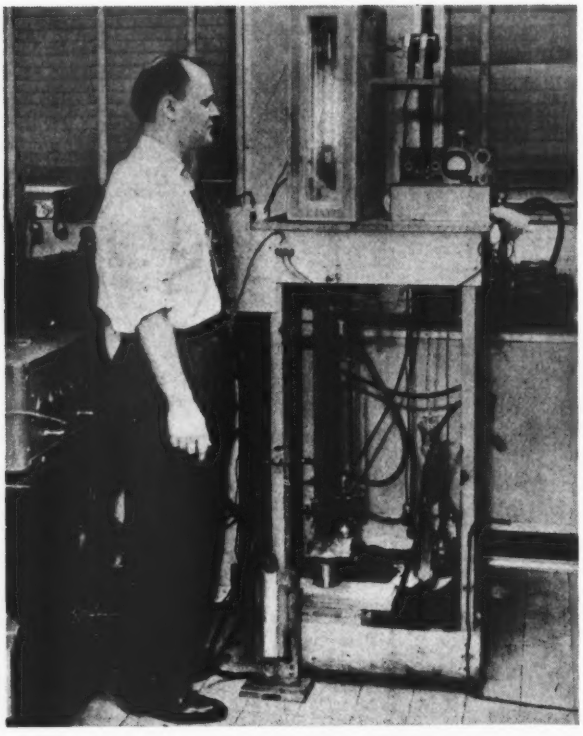
Fractionating a polybutadiene resin.

United States for textiles and laminates brings into relief the importance of the surface structure of these fibres, and much of the work of the glass scientists is concerned with the intricacies of the fine structure of glass surfaces. Notable advances have been made in this field, amongst which is the development of a carbon replica technique for the study of glass surfaces by the electron microscope. A thin film of carbon is deposited under vacuum on to the glass or silica surface and the substrate is subsequently leached away with hydrofluoric acid, leaving an exact replica in carbon of the original glass surface.

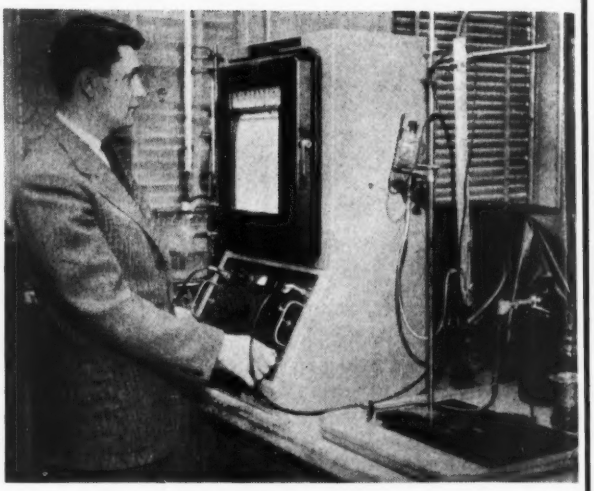
Among other problems being tackled at the Institute are the evaluation of polyethylene/hydrocarbon wax blends for paper coating, the development of barrier coatings for improving the impermeability of polyethylene containers to essential oils and perfume preparations, the development of latex paints for external use with improved corrosion resistance properties, the evaluation of polyester intermediates in the production of polyurethane foams and sponges, and the development of novel types of amine catalysts for epoxy-resin coatings and adhesives. In fact, the wide range of work now being carried out reflects quite accurately the immediate interests and aspirations of the American high polymer industry of today, and it would be difficult to suggest a centre more suitable than the Mellon for obtaining a " bird's eye view " of high polymer science and technology as it exists in the United States.

Organization and Policy

Lest it be thought that the whole of the work of the Institute is sponsored by interested commercial organizations, it is well to note that many long-range fundamental investigations are being made with no apparent specific economic objective. These are being performed by the research departments of the Institute of which there are now six. These are the Departments of Applied Mathematics, Analytical Chemistry, Chemical Physics, Instrumentation, Physical Chemistry and Radiation Research. This last department was announced in 1956 and, when fully operative, will possess its own 3-million-volt Van de Graaff accelerator, radio-active sources and radiochemical laboratories.



The stress relaxation of rubber is shown being measured in a vacuum.



Polarographic analysis is used to gain information concerning the functional groups on carbon black.

These departments are the true strength of the Institute. Their primary function is to generate new ideas and bring to light new facts concerning natural science. It is the opinion of the board of trustees of the Institute that applied science and technology have, in recent years, made such enormous advances that pure science has by comparison been left behind. Accordingly, present plans are being laid with a view to encouraging the development of fundamental work, totally unactuated by motives of future utility. Of course, this is not to say that such work will be barren in this respect. It will be the task of these six departments to organize and implement this programme, and it is significant that the finances of these departments are to be augmented by the recent establishment of a " Fundamental Research Trust " by Mellon family benefactors. It is hoped that further support for this " disinterested " research programme will be forthcoming from American industry and the U.S. government. One cannot help feeling that it is along these lines that science, and therefore human happiness, is best nourished and served.

(To be continued.)

Assessing the weathering characteristics of paints based on synthetic latex.

World's Industry Employs Plastics

The original articles from which these abstracts are taken can be seen at the Patent Office Library, 25 Southampton Buildings, Chancery Lane, London, W.C.2. Photostat copies can be obtained from the same source, price 1/6 per page (postage extra). It should be noted that the page number given below the abstract is that of the page on which the article commences.

MATERIALS

Plastic Floor Coverings

A STAND-BY-STAND report on that section of the recent Interbau Industrial Exhibition dealing with floor coverings. It is noted that about a dozen companies exhibited plastic floor coverings and that one organization in particular, Pfälzischen Plastic Werke erected a demonstration pavilion consisting of a bare steel framework with all the rest of the assembly, including floor coverings, in plastic to show the weather resistance of these materials and especially that of the company's " Pegulan " floor covering consisting of a laminate with a working face of p.v.c.

(*Tapeten Zeitung*, 1957/Nov. 20/20.)

Plastisols for Corrosion Protection and Decorative Effects

ALTHOUGH plastics are finding constantly increasing use in a variety of fields for purposes of decoration and corrosion protection, their use is limited in many instances by reason of the higher processing costs involved as compared with those associated with the usual lacquers. Synthetic resin dispersions have now been produced which may be used in the same way as lacquers either by spraying or by dipping. They give protective coatings offering many advantages over those given by the conventional lacquers. Thus thicknesses of several mm. may be obtained. They possess high elasticity and have high abrasion and shock resistances. In addition they are free from porosity and have inherently high chemical stability. Local damage does not result in exfoliation. Under the name " Unichrome-Überzugsmaterialien," T. H. Goldschmidt A.G. Chemische Fabriken of Essen.1. is producing dispersions in various grades for hot dipping, cold dipping and spraying. To obtain maximum adhesion it is advisable in every case to use first a primer which is stoved at 180° C. Immediately on completion of stoving, the work may be plunged into the hot dipping dispersion or, if the ground coat has not been used, it should be dipped in after heating to 160°–180° C. Thickness of deposit may be varied by varying the temperature of the work piece and the time of immersion. After removal from the dipping bath the work is allowed to hang a short time in the air and is then stoved at about 180° C. The cold dip method is used for metal work of light section, say wire, where any attempt to hot dip would be rendered difficult by the rapid loss of heat of the object. If such light section work is given a priming treatment, then, before dipping, it must be allowed to cool. As before, the dipped work is stoved at about 180° C. For large objects spraying techniques may be used, using the normal spray gun at normal pressures. With one pass it is possible to obtain a coating thickness up to 0.5 mm. The work is sprayed in the cold state, the coating then being stoved at 180° C. For various purposes dispersions are available in a variety of colours and various hardness grades.

(*Der Plastverarbeiter*, 1957/Nov./413.)

Stiffening Shoe Toecaps

WALTER SCHUMANN describes the requirements of a material satisfactory for stiffening the toecaps of shoes. Those based on nitro-cellulose, although otherwise satisfactory, entail fire hazards and some health risk amongst operators. A more recently developed thermoplastic type was found to be too sensitive to moisture whilst a mouldable type described as " water soluble " also proved lacking in certain respects. Melamine-formaldehyde resin was experimented with in various ways on textile and other bases and on foils, but did not entirely meet all requirements. Recent developments by the VEB Leuna-Werke Walter Ulbricht in conjunction with the Zentralen Forschungs und Entwicklungsstelle für die Kunstlederindustrie have resulted in the production of a material of satisfactory properties. No composition is given but it is described as " water soluble " virtually non-inflammable and self-adhesive. In forming it, no solvents are required, only water has to evaporate in setting and its working properties are such that high output rates are possible whilst working costs are low. The rigidity and mechanical strength of the material are such that it commends itself for adoption in place of steel in safety shoes for industrial use.

(*Schuh und Leder Zeitschrift*, 1957/Oct./306.)

MACHINERY

AFTER an introductory account on the vacuum forming process generally, its advantages and limitations, and its incorporation into more complex working cycles involving the preliminary use of positive forming, Riemenschneider refers to the " Plastiplast 55 m. " machine of Vogt Hartmann (Mainz-Weisenau), exhibited at the Industrial Exhibition at Hanover in 1955 and representing the first forming process involving positive and vacuum forming with prestretching. The author indicates that, in principle, the process remains one of vacuum forming, however. Conditions necessary to obtain the best results by the new system are set out and the possibilities of the process are demonstrated pictorially by a series of illustrations showing the various stages in the production of a complex shape.

(*Der Plastverarbeiter*, 1957/Nov./417.)

Loose Leaf Binders

AN account of spiral binding methods and equipment for producing the necessary spirals in metal and plastic. It is based on the products of Bohn & Company, Stuttgart. A detailed description is given of a machine for producing p.v.c. spirals from coiled p.v.c. " wire," the p.v.c. wire being heated electrically in the machine and formed to a spiral when in the soft state. The application of various coloured covering sheaths in plastic to spiral bindings is also dealt with.

(*Allgemeine Papier Rundschau*, 1957/Oct./1016.)

High Frequency Welding

IN a review of industrial type magnetrons, Schmidt examines their design, operation, service life and typical applications—including that for providing high frequency current for welding plastics. He notes that the demands made on apparatus for this purpose are very severe; it may be in operation for 5,000 working hours per year. A number of types of magnetrons manufactured by Valvo GmbH., are illustrated.

(*Blektronische Rundschau*, 1957/Oct./306.)

Post-Formed Phenolic Laminates

A DESCRIPTION of the methods employed in post-forming phenolic laminates is given. Particular attention is given to the heating of the laminate which is a critical factor as it must be applied rapidly and uniformly. Three methods are suggested: Infra-red oven, infra-red strip heaters and heated platens. Other subjects dealt with are the choice of material for the die and the shaping operation. One of the problems involved is the inherent stresses induced in the material and the resulting spring-back when it is removed from the die. This can be overcome by observing three precautions in heating cooling and forming.

(*Prod. Eng.*, 1958/Feb. 17/66.)

TECHNOLOGY

Concentrating GR-S Latex

FINDING an efficient method for concentrating to marketable solids, cold GR-S latex which is polymerized at low temperatures, has been a major problem.

Using a continuous column concentrator, this latex has been concentrated efficiently with minimum foaming, entrainment losses, and coagulation caused by thermal shock or mechanical instability. Operator attention has been reduced, and down time, necessary for charging and discharging in batch processing, has been eliminated.

H

This method, used for over three years to produce commercial latex, has minimized maintenance and operating costs.

(*Ind. Eng. Chem.*, 1957/Nov./1835.)

Curing Process in Phenolic Resin

TO correlate mechanical and electrical properties of polymers with chemical composition and molecular structure, curing process of a phenolic resin was followed using X-ray diffraction and electron microscopy.

X-ray diffraction provided a new measure for extent of cure—position of the scattering maximum is shifted to smaller scattering angles with increasing cure.

An electron microscope showed that this resin has a micellar structure where the micelles are spherical or spheroidal and somewhat more cohesive than intermicellar zones. After 480 hours of cure at 176° C., average micellar diameter decreased. Various techniques of preparing samples were developed for observing both fracture surfaces and sections.

(*Ind. Eng. Chem.*, 1957/Nov./1838.)

Nuclear Radiation and Plastics

A REVIEW by Porejko and Brzozowski, based largely on English and American work, of the effect and utilization of atomic radiation on different types of plastic or plastic raw materials, especially monomers. The basis of the reactions is discussed and some practical details are given. Some useful tabular and graphical data are given, including one showing the percentage conversion of monomers exposed to radiation and another showing physical and mechanical effects of radiation of high intensity on various types of plastics including the phenolics, polystyrene, aniline-base plastic, polyvinyl chloride, casein and others.

(*Przemysł Chemiczny*, 1958/Jan./8.)

Technology of Alkyd Resins

JEDLIŃSKI presents a review of the chemical problems involved in more recent developments of alkyd resin technology. In particular he touches upon the reaction kinetics involved and indicates trends of future progress.

(*Przemysł Chemiczny*, 1958/Jan./12.)

Some Chemical Reactions with the Epoxy Resins

A LENGTHY review by Penczek, with an English summary, of chemical processes occurring during the hardening of mixtures of epoxy resins and phenol formaldehyde resins and others. The data presented include observations on the molecular weight of the products obtained and also on the electrical properties of the product resulting from the interaction of novolac and epoxy resin.

(*Przemysł Chemiczny*, 1958/Jan./35.)

Urea-formaldehyde Condensation

A DETAILED study by Wirpsza of the chemistry of the condensation processes occurring in the industrial preparation of urea-formaldehyde resins. The author examines the course of the reactions for various concentrations of the components for various *p*H values and for different reaction times. His results are presented in a series of detailed graphs and tables. The account includes an English abstract.

(*Przemysł Chemiczny*, 1958/Jan./38.)

TESTING

Electrical Standards in Russia

IN an account by Melone on electro-mechanical standardization in Russia, reference is made to GOST 7006-54, dealing with insulators. In these, specifications are laid down for "Bakelite" and "Textolite," as well as for other insulating materials.

(*Industria Italiana Elettrotechnica*, 1957/Nov./382.)

APPLICATIONS

Special Underground Cable

AN account by Henze and Wiechmann of the design and laying of a special underground cable in the mountainous Montafontal region between Bludenz and Schruns in Austria. The topography here is such that the use of overhead lines was not considered advisable. Three cables were laid, one for each phase, designed to operate at 20 kv. with a total loading of 4 MVA. Insulation consisted of a special "Protodur" mix, the cores being of hard drawn copper. It is stated that had polythene insulation been used, larger conductors would have been required in order to accommodate any unforeseen overloading. In place of the commonly used lead sheathing, Protodur is also employed, its hardness and toughness enabling it to meet the severe conditions encountered when buried in rocky soil. The terminal ends of the underground cable at the power station are sealed with a special "Protolin" casting resin, compatible with Protodur. The resin was cast around the junctions in moulds which were removed after it had set. Other use for Protodur insulation and sheathed cable are noted. The nature of Protodur and Protolin is not disclosed.

(*Siemens Zeitschrift*, 1957/Dec./617.)

New Hand Lamp Design

IN a long account reviewing progress in modern lighting systems up to the end of 1957, reference is made to an 8-watt handlamp, of the fluorescent type, in which the lead, plug, switch, starter and choke equipment are all enclosed in neoprene, the oil resistance of which is noted. A glass clear shatter-proof Perspex tube protects the lamp itself. It is manufactured by Elwis, Grusbakken 12, Gentofte, near Copenhagen, Denmark.

(*Elektroteknikeren*, 1958/Feb./65.)

Electrostatic "Tweeter"

GARY, in a mathematical analysis of the principles of the electrostatic loudspeaker, refers to "tweeters" devices for reproducing very high frequencies. The diaphragms of these, which also function as the dielectric for the condenser system, consist of a metallized plastic film; the nature of the plastic is not stated. The theory of the operation of the apparatus is described with due reference to the function of the plastic.

(*Revue du Son*, 1958/Jan./3.)

Plastics in Mechanical Constructions

A SUMMARY by Henri Drapier of the use of plastics in mechanical engineering constructions. The author commences by enumerating the physical, mechanical, chemical, electrical and other basic properties of plastic materials in general and then goes on to consider their uses in the automobile industry, aircraft industry, marine engineering, railway engineering, mechanical engineering generally, the textile industry, precision engineering and refrigeration engineering.

Typical applications are given under each of these headings and the various types of plastics used are noted.

(*France-Industries*, 1957/Oct./23.)

Plexiglass Lighting Fittings

ATTRACTIVE lighting fittings designed as integral parts in shop architecture are made from Plexiglass supplied by Röhm & Haas. The fittings are constructed of rod, sheet or strip with plain or hand tooled surfaces and in plain or coloured material. Emphasis is laid on the ease with which Plexiglass may be formed and on the low light-loss obtained with fittings made of this material. Amongst the fittings illustrated are those by Karl Roters, Munich, and Wwe. Wilh. v. Hagen, Iserlohn.

(*Deutsche Uhrmacher Zeitschrift*, 1957/Nov./484.)

Machine for Cleaning Carpets and Floors

AS an appendix to an account summarizing papers and discussions presented before the Convention of Dyers and Chemical Cleaners held in Stuttgart in September 1957, is included an alphabetical list of manufacturers who exhibited plant and materials strictly entitled to be called new developments. In the list are numerous items of interest to those engaged in the cleaning and dyeing of synthetic fibres of all types, including cleaning compounds and equipment. Reference is made to a universal cleaning machine for carpets and industrial floors: this is of new design and is equipped with Perlon brushes.

(*Der Chemischrenigier und Färber-Färber Zeitung*, 1957/Oct./327.)

Purifying Industrial Effluent

CONCLUDING section of an account by Müller summarizing a recent Effluent Convention held at Iserlohn in Germany. Detailed reference is made to the Degussa method for rendering harmless effluents containing heavy metals and cyanides in particular. An illustration is presented of an apparatus for handling industrial effluent which is set up in the State Engineering School for Mechanics at Iserlohn. Numerous components in this assembly are made of Vinidur, polyethylene and p.v.c.

(*Galvanotechnik*, 1957/Nov./479.)

Spark Machining Aids Die Sinking

This technique has now been utilized for three years by the Witton Moulded Insulation Works of the General Electric Co., Ltd., employing spark machining apparatus made by Wickman Ltd. This progress report is illustrated by photographs taken at G.E.C.'s Witton factory.

IN the production of dies for plastics switchgear parts and so on, the machining of deep irregular-shaped cavities on a milling machine is a particularly difficult process and cannot be performed by hobbing because of the limited area. The milling cutters are small and relatively long, and the time taken to machine the cavity represents a high labour cost. Moreover, switch levers must be produced in split dies and the trimming line detracts from the appearance of the finished component.

Labour Costs Reduced

During the last three years, The General Electric Co., Ltd., have been employing the spark eroding method at the Witton Moulded Insulation Works, Birmingham, to machine deep cavities in dies, and in many instances this process has reduced the labour cost by 50%. It has also afforded advantages with regard to finish, and, of special importance, the machines can be employed to modify or recover a die without affecting the hardness or other properties of the metal and the process does not cause distortion. The metal employed for the dies is air-hardening nickel steel and the tools are used for moulding various plastic materials.

The machines are of the Erodomatic W/UV type produced by Wickman, Ltd., Coventry, which is the largest machine in the concern's range and has a rating of 6.6 kVA. Power from an a.c. source is supplied to a power pack, the d.c. output of which is fed to a spark-generating circuit.

Given that the workpiece is an electrical conductor, any material can be machined, and an outstanding feature of the process is that machining time is not affected by the hardness of the material. In many cases it is the only alternative to grinding.

Material is removed from the workpiece by means of repetitive electrical sparks of short duration and accurately controlled magnitude. The energy of the spark discharge performs the dual function of fusing small areas of the workpiece and separating the fused particles from the parent stock by creating a condition of "mutual repulsion."

Distortion is avoided because the spark duration is so short that heating is confined to the spark area on the surface of the material. Movement of the electrode spindle is accurately controlled by a servo motor to maintain a constant spark gap between the electrode and workpiece.

In contrast to conventional machining methods, the cutting electrode is not in physical contact with the workpiece and no stresses are imposed on the electrode or the worktable. Machining is performed in a tank of dielectric fluid, and the electrode is subjected to small amplitude vibrations to wash away the particles from the cutting zone. In another machine of the Wickman range the worktable is vibrated instead of the electrode, which is of advantage if a heavy or multi-element electrode is required.

Brass electrodes are normally employed, and at the Witton works they are produced from standard bar stock if the shape of the tool is of simple form. More complicated electrodes can often be made by normal casting methods, a finished part being used as the pattern, or, for example, by forming sheet brass to the required shape. An electrode of this type is employed at Witton for producing the die cavities for the flash buttresses of switch covers, which are of deep irregular shape and have curved sections of small radii.

Speed of Machining

Speed of machining depends upon the finish required and in practice the first cut is made by a roughing electrode at a relatively high speed and a second electrode is employed for the finishing cut. Wear of the electrode during the machining process precludes its use for repeating the same cut, but it may be reduced in size for a second operation. If a wide range of electrodes of similar shape is required, one electrode may be employed for several operations. The cost of electrodes is not, therefore, a serious factor.

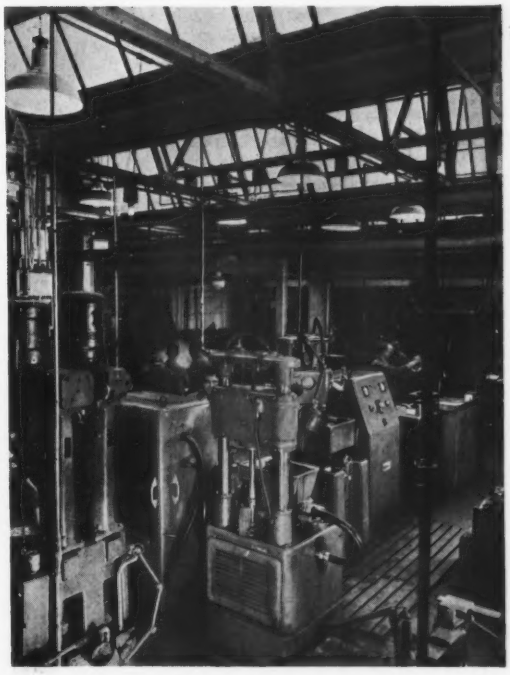
The process is fully automatic and the machine is switched off by the control unit when machining has been completed. The work of the operator is limited to setting-up the electrodes and dismantling, which can be performed by the average tool-room machinist after a short period of tuition. Maintenance of the Wickman machines in the insulation works has been negligible, the only replacements required being valves of the control unit.

In the production of the plastics dies, the finish corresponds to a good sand-blasted surface, and the die for a typical switch lever can be suitably polished in approximately one hour. Apart from the advantage of obviating a lengthy milling process and the use of a split die, the need for filing machining marks is also eliminated and polishing time is reduced. The improved surface reduces the tendency of the material to adhere to the die surface.

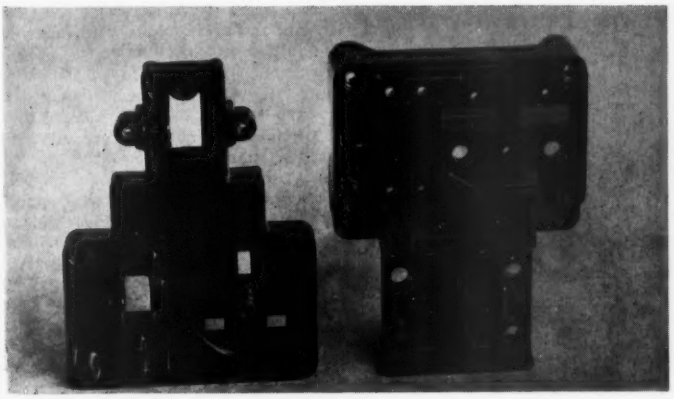
Other interesting uses of spark machining by the department include the drilling of feed holes of diameters down to 0.007 in. This greatly simplifies production of the feed element, which formerly comprised a number of small segments clamped together.

Cutting small slots in tyre moulds is also

(Right) Two Wickman machines are employed at Witton for spark machining deep cavities, and for the modification of existing dies.



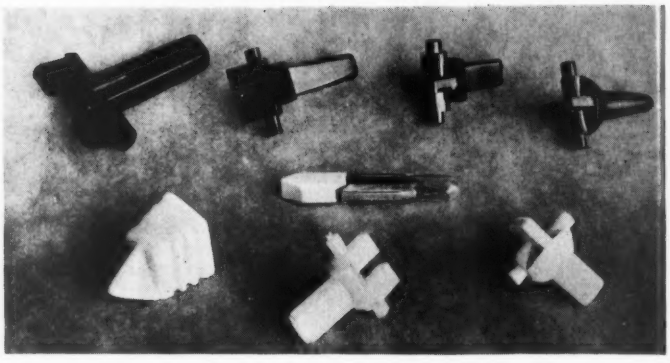
(Below) Mouldings produced from partly spark machined dies.



performed with advantage by spark machining. In one case slots with a width of 0.018 in. and a depth of ⅜ in. were cut by this method.

According to Wickman technicians some reduction in the dimensions of a deep cavity is inevitable on account of the electrode wear, but with fine cuts departure from the parallel is reduced to 0.0015 in. per ½-in. length. For many die sinking operations, however, this slight taper is an obvious advantage.

For normal production processes, an electrode is used for the final cut, which gives a finish of 40 micro-inches, but a super fine finish can be obtained of 14 micro-inches. A rough cut gives a mottled effect which could be of value as a decorative finish for some plastics parts, including cover plates and so on.



G.E.C. components moulded from dies where spark machining has been employed.

Pigmenting Plastics

New Research Facilities for Acheson Industries (Europe) Ltd.

AMONG plastic articles today, it is difficult to find examples which are not coloured. Colouring of plastics is as essential as moulding finish or mechanical properties, and in most cases the colour provides an æsthetic or sales appeal. In many industrial applications, the pigmenting provides an essential technical property, but in both instances there is a common requirement to be fulfilled in the pigment; it must be adequately dispersed. By "adequately" is meant "homogeneously," which in turn indicates other requirements, such as stability, economics and other factors.

Pigmenting

The incorporation of a pigment or colour into a solid resin can be accomplished in various ways, of which the three principal methods are by Bridge Banbury, rubber roll mills and extruders. One can also approach the problem by indirect means, where the solid resin is plasticized, the pigment being put into the plasticizer first.

In view of the need for a specialized approach to the problems of pigmenting, Acheson Dispersed Pigments some time ago set up a pilot factory at Slough. In 1957 this was transferred to Dukinfield, Cheshire, where a large modern factory was built for the purpose. A.D.P. Company, as it is now known, is a unit of Acheson Industries (Europe) Limited, 18 Pall Mall, London, S.W.1, and is associated with similar Acheson activities in the U.S.A. at Philadelphia and Orange.

Quality Control

One of the essentials in processing pigments into resins is the control of particle size and dispersivity. If a masterbatch is unhomogeneous, this defect is likely to come through in the extensions and finished products, being expressed as streaking or uneven colour values. Where carbon black is incorporated into polythene used in cable covering, the efficiency of the dispersion of black in the resin is reflected in the life of the covering. Poor dispersion means premature breakdown of the resin as a dielectric in service.

It is easy to see that adequate quality control is of prime importance. For that reason, the laboratories must be well equipped for optical inspections and routine analyses. The accompanying pictures of the laboratories at Acheson Dispersed Pigments Company illustrate this. Emphasis must be placed on dark room work or the optical laboratory. When used intelligently, the microscope can be the simplest and most reliable routine check on quality.

But what are the standards for assessment? The evaluation of black masterbatches of polyethylene and polystyrene have provided a subject of controversy in Britain and America. There is a divergence of opinion among technologists themselves within various countries, and this has prompted the Acheson organisation to adopt a scale of microscopic standards for black masterbatches, which is common to their units in the U.S.A. and Britain, based on work done in the Bell Telephone Laboratories and Western Electric. The method is empirical and was drawn up by the Philadelphia laboratories of Acheson's after some years of customer experience. Briefly, it uses a masterset of specimen slides representing quality that has been proved to answer service requirements, and day-to-day plant production is matched against the standard.

Carbon and mineral pigment contents of masterbatches are determined by distillation of the resin in nitrogen. This method was adopted by one of the Acheson units in Britain some years ago, but has received wider interest in the past year or two as a tentative A.S.T.M. method.

(Left) Quality control laboratory.

From these brief remarks, it will be evident that quality control is something more than an ancillary to the production of masterbatches. There has been room for improvement in this direction and it is anticipated that the use of more refined techniques will throw up indications of the way to make better dispersions more economically.

Pastes

There is a steady demand in Britain for concentrated dispersions of colours in plasticizers and other carriers. This calls for different equipment and technical approach from solid dispersions. The avoidance of pigment settling, viscosity control and other factors enter into this type of work. The Acheson plant at Dukinfield is equipped for this, the associated unit at Plymouth having made colloidal dispersions for nearly fifty years, so that there is a considerable technical background to this activity.

Process Control at Dukinfield

There are two primary aspects in work of this kind. The fact that users of pigments in plastics prefer masterbatches to be prepared outside of their own plant because of the dangers of contamination underlines the need for a specialised set-up, as at Dukinfield, to guard rigorously against dusting. This is accomplished by careful design of extractor systems and siting of machines. Furthermore, the need to remove unwanted pigments from the air means that a recovery system must be set up to avoid losses. These have all presented problems which have been surmounted at Dukinfield.

The second aspect of the class of work is processing time control. Many machines may be engaged, simultaneously, on different operational cycles, for different pigments, and vehicles call for individual treatment. As with a machine shop in the engineering world handling a variety of components, it is imperative to exert some measure of centralized co-ordination. Acheson has carried out this co-ordination by installing a dialling system on each machine, similar to an automatic telephone system. At the commencement of a machine operation the operator dials a code number which transmits an appropriate signal to recorders in the costing office. The recorder commences to log time, power consumption and other factors. The end of the machine run is also signalled, and it is not necessary for the cost clerks to handle any cards or written data from the factory floor. Machine produced data of this kind can also be studied to advantage by the production people.

New Materials from the U.S.A.

1. Polyethylene Oxide Resins

NEW high-molecular-weight polyethylene oxide resins with outstanding properties for many toilet goods applications, were recently described by spokesmen of Union Carbide Corporation.

These materials, commercially available under the trade mark Polyox, are a new group of water-soluble resins. They have a remarkable ability to thicken water, the viscosity of one per cent. aqueous solutions ranging up to 10,000 centipoises. Aqueous solutions of the resins, moreover, have shown no tendency toward biological decomposition. Other properties believed to be of particular interest to cosmetic and pharmaceutical chemists are the extremely high lubricity these resins impart to formulated compositions, and their compatibility with detergent compositions, high concentrations of electrolytes—including aluminium salts—and many organic solvents. Films prepared from these polyethylene oxide resins by castings or by milling are tough, flexible, resistant to oils and greases, and essentially non-hygroscopic.

Toxicity

Initial toxicological evaluation of these new materials has been completed. These preliminary studies indicate that these resins are low in toxicity to animals and non-irritating and non-sensitizing to the skin of laboratory animals. Therefore, further evaluation of these new materials in toilet goods and cosmetics seem warranted. Further toxicological studies are under way and will be reported at a later date. A few of the many possible applications include shampoos, synthetic detergent bars, toothpaste, and hair sprays.

Shampoos, hand cleaners, and manual dishwashing compositions with enhanced consumer appeal can be formulated by using relatively inexpensive detergents in combination with the new resins. They impart high lubricity to both the detergent solutions and lather, as indicated by the feel on the skin and hair. Incorporation of low concentrations of polyethylene oxide resins in alkyl aryl sulfonates eliminates the tacky sensation characteristic of these detergent bases, and makes them suitable for use in personal products. Many other surfactants which have an almost non-lubricating type of foam, moreover, produce lather exceeding soap in lubricity when Polyox resins are present in the composition.

The new resins may solve problems associated with the development of synthetic detergent bars for toilet use. Addition of a small amount to formulations substantially improves the creaminess of the lather and skin feel. Satisfactory detergent bars have been prepared using dodecylbenzene sodium sulfate with one or two per cent. Polyox resin.

Use in toothpastes

In toothpastes, Polyox resins are good binders for the abrasives and they are compatible with the high ratio of humectants to water normally used. However, their most important contribution is improved mouth feel, presumably due to the lubrication properties of solutions of these resins. Of particular interest in view of the popularity of fluorides in toothpastes, is the fact that these resins are not adversely affected by water-soluble salts. Polyox resins are not advised in soap-based toothpastes, however, unless a non-foaming product is desired, for they reduce soap foam. Conversely, when compounded with anionic surfactants, they enhance foam.

Aerosol hair sprays can be compounded with the new resins. Here an important feature of these resins is the low hygroscopicity of their films. Dimethyl hydantoin-formaldehyde resin is incorporated to impart adhesion to the hair, and lanolin derivatives and esters of fatty acids may be included for gloss. The flexibility of the film can be improved by the addition of ester-type plasticizers. But since the resins are not soluble in anhydrous alcohol, a change from the usual alcohol-propellent combination used in aerosol hair sprays, is necessary. Instead, methylene dichloride is suggested as the solvent with a combination of methyl chloride and fluorinated hydrocarbon as the propellent. Because methylene dichloride is non-flammable, only a relatively small amount of fluorinated hydrocarbon propellent is required for non-flammable product.

2. Polyethylene Melt Coating Resins

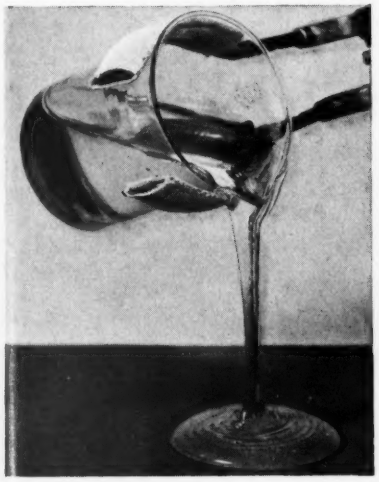
A NEW polyethylene resin has been introduced by Eastman Chemical Products, Inc., which is expected to add still another dimension to the use of this fastest growing family of plastic materials. Identified as Epolene "C," the new type polyethylene possesses many of the properties generally associated with plastic grade resins and yet can be handled much like a moderate to high melting point wax.

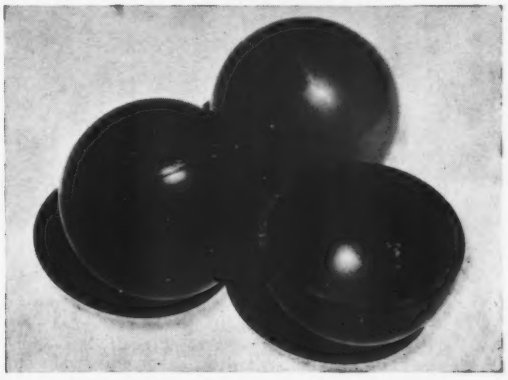
Because of its wax-like characteristics, Epolene "C" can be handled as a melt, with or without modification. At 300° F., for instance, the viscosity of the new resin is 8,000 cps. The addition of 25% paraffin, with which it is completely compatible, reduces the viscosity to only 1,300 cps. at this temperature.

Three general areas of use are foreseen for the new material and are being rapidly investigated. As a melt casting, it can be employed with or without the addition of colouring agents to form relatively hard, tough cast or slush moulded objects. To further extend this use lacquers are being developed to decorate such products as dolls and toys. As a hot dip, its application as a protective coating to a wide variety of products is being investigated. As a hot melt, it can be applied to virtually all types of paper, comparing favourably with coatings achieved by the extrusion of plastic grade polyethylene.

As a paper coating material the new low-melt polyethylene can be handled in conventional wax coating machines with only slight modifications including provisions for higher temperatures in the fountain. A more complete bond is formed between the coating and the paper than is possible by extrusion coating since the melt penetrates into the paper to a much greater degree. An unusually high gloss can be achieved, and paper can be coated on both sides if necessary.

The new low-melt polyethylene is produced by Texas Eastman Company in Longview, Texas, and is available from Eastman Chemical Products, Inc., subsidiary of Eastman Kodak Company, Kingsport, Tennessee.

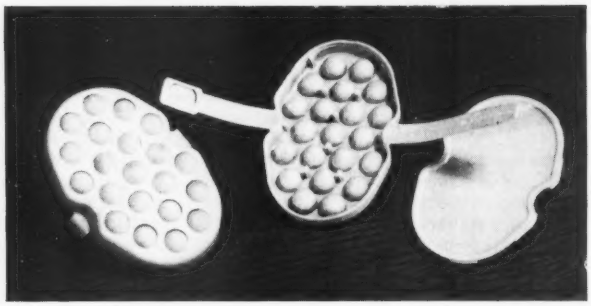




(Left) At 300° F. the polyethylene resin flows like a thick syrup (8,000 cps.).

(Right) Slush moulded articles in Epolene "C" low-melt polyethylene.

New Productions



(Left) Polythene massage pad moulded by Initial Plastics Ltd. which was recently offered to its readers by a woman's magazine.

(Above) Blown polythene Worcester Sauce bottles made by Cascelloid for Hax Ltd.

Vinyl Stairnosing

A new flexible stairnosing has just been introduced by The Marley Tile Company, combining exceptional durability with a neat and non-slip tread. Made of a vinyl composition material, it is fully flexible and, fixed with Marley M8 Adhesive, provides a permanent feature.

There are four patterns, three of them for use on concrete or stone stairs and with angles of tread-to-riser of 90°, 80° and 70° respectively. The fourth is bull-nosed, for use on wooden stairs.

The three angled patterns have treads 2½ in. wide; the tread of the bull-nosed is 1¾ in. wide. The stairnosing is ⅛ in. thick.

There are three stock colours, black, brown and white, and the standard length is 9 ft. run. Special colours and lengths could be made to order if desired.

Plastic Wind Tunnel Models

Plastic foam resins are providing Chance Vought Aircraft with an economical method of turning out small wind tunnel models in quantity.

Instead of making the models by hand out of balsa wood or constructing them of glass fibre with balsa wood bulkheads, the foam plastic method was adopted because it produced a light, strong model at lower cost.

Foam was used to produce two specific models for wind tunnel testing—several configurations of a droppable fuel tank and of an ejection capsule for pilot escape in high speed aircraft. Glass fibre moulds were constructed to turn out different configurations of the tank. The mould for the capsule was made from Devcon " B " to withstand distortion from heat during casting. Close tolerances were required for both models.

To produce an excellent outer surface, glass fibre cloth is first laid in the mould wet after the mould has been waxed to prevent bonding. After the foam is poured into the mould and allowed to set the finished model produces a smooth surface, with more rigidity and hardness.

Non-corrodible Lighting Fittings

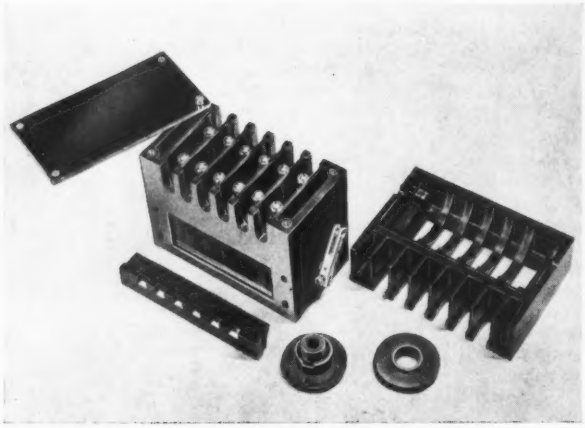
Two new non-corrodible lighting fittings now being marketed by The General Electric Co., Ltd., have been specially designed for use in food factories and other installations where corrosive vapours are present. The fittings, which incorporate an entirely new method of suspension, are largely of plastic construction and have no external metalwork.

The reflector of each fitting is formed in opal Perspex and is sealed into a front cover of clear " pin-spot " Perspex. The combination of finishes ensures an adequate upward illumination while the maximum light output is directed downwards. The top cover is of dense opal Perspex which clamps tightly on to a sponge Neoprene gasket fixed to the main reflector body.

The suspension system ensures a satisfactory seal without the use of fixing screws by allowing the weight of the fitting to perform the clamping action. Each fitting is suspended by three independent Terylene cords, each cord having a breaking strain of about 250 lb. The suspension cords are secured to ceiling plates of ⅛ in. thick p.v.c. with fixings at 2 in. centres. Two 2 B.A. nylon screws are included for the B.S. box, fixing at 2 in. centres.

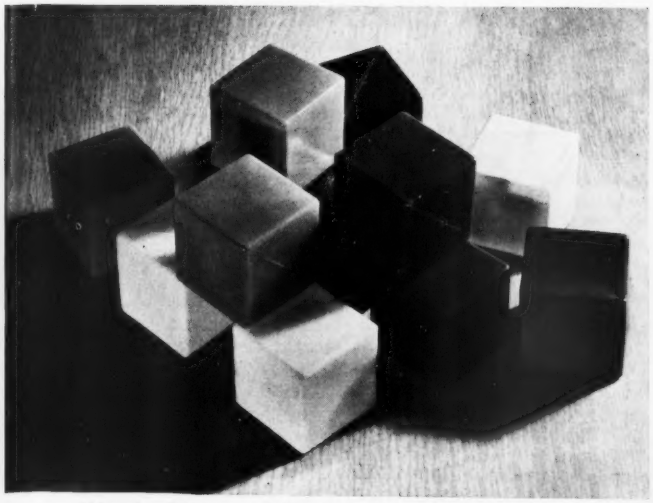
New Warerite Wallboard

A new moisture-resistant, Warerite-faced hardboard has been introduced by Bakelite Ltd., 12 Grosvenor Gardens, London, S.W.1, for use on all types of vertical surfaces and ceilings. Known as Warerite Wallboard, it consists of a high density fibre hardboard core surfaced on both sides with melamine resin impregnated papers moulded under heat and pressure. One face incorporates a decorative Warerite pattern and the other is a plain compensating surface to protect the core from moisture and to prevent warping.

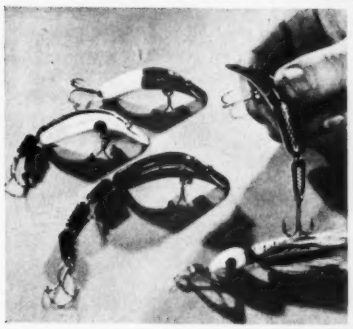


" Elo " mouldings in new switch. Birkbys Ltd., of Liversedge, Yorkshire, produce the various mouldings seen in this photograph, used by Whipp & Bourne Ltd., of Castleton, Rochdale, in their new circuit-breaker six-way auxiliary switch, 10 amperes maximum rating.

Polythene hot water bottle and cap made by Fibrenyle Ltd.



(Above) Blown polythene building bricks manufactured by Shipton Plastics Ltd., Ferndown, Northwood Hills, Middlesex, who are now producing a range of novel plastic toys.



(Right) Fish lures moulded in Tenite butyrate by Oster's Bait and Tackle Manufacturing Co. of Cleveland, Ohio. The lures weigh approximately ¼ oz. and are unaffected by salt or fresh water.

(Right) Illustrated is the Guard's Van Chair which Universal Metal Products Ltd. are making from glass-fibre reinforced plastic material for British Railways. This material was specially selected for the moulding because of its strength and light weight.

(Above) For their Plasmatic diffuser panels Tube Lamination & Engineering Ltd., High Wycombe, use Erinoid light-stabilized, light-diffusing opal polystyrene. The photograph shows Plasmatic ceiling lighting installed in the new offices at St. John's, Hazlemere, Bucks, for The Equity and Life Assurance Society.

(Above) The latest Pye battery portable, the P.114 BQ Jewel Case is covered throughout with Everflex leathercloth made with Geon p.v.c. Everflex leathercloth is made by Bernard Wardle (Everflex) Ltd., Peblig Mill, Caernarvon.

(Right) Claudgen sign outside the Union-Castle Line's offices in Old Bond Street, London. The letter faces are of opal Perspex, lluminated from the rear. The projecting box signs are of red, white and blue Perspex lit internally.

Machines for the Industry

Herbert/Reed-Prentice 4-oz. Injection Machine

THE present design of this 4-oz. machine is the natural development from an existing machine originally known as the Reed-Prentice 5A 4-oz. With this new model various desirable features have been incorporated to make it a highly efficient moulding unit. This machine is one of a range of " Reeds " now built in this country under licence by Alfred Herbert Ltd. The normal shot capacity is 4 oz. which can be increased to 6 oz. using the double shot mechanism which is built into the machine as standard equipment. It is entirely self-contained and hydraulically operated. The control station is centralized and all operating push-buttons are easily accessible to the operator. There is a choice of cycle control, manual, semi-automatic or fully-automatic operation, the selection being easily obtained by a rotary switch. It is easy to operate, reliable and capable of maintaining high rates of production. A 6-second dry cycle is obtained through fast positive toggle action and high injection speed.

Heating Cylinder

The efficiency of any injection moulding machine is very much dependent upon the heating cylinder design and this machine is now offered with the patented Herbert low voltage system of induction heating (1). This particular system has many advantages when compared with standard resistance type heating bands. Heating up time from cold is much shorter, and power consumption is lower, coupled with extremely accurate temperature control. With the type of coils (2) used the life is indefinitely long. Plasticizing capacity is increased by up to 30% dependent always, of course, upon material and mould conditions. Furthermore, cylinder temperature is easily maintained by standard on/off pyrometers. The spiral coils are rectangular sections of pure nickel wound to form an element around the cylinder and are insulated from it by a lapped layer of asbestos tape, except at points of common return. The element itself is only insulated by the air between the turns. Pure nickel was chosen for this application due to its resistance to oxidation at high temperatures. Three heavy leads are connected to the coils and the common return to the cylinder from the transformer (3) which is mounted on the top of the injection cylinder carriage (4). Because of the low voltage employed, little more than a mechanical interference is required between the coils and the cylinder for the purpose of insulation and because of the incombustible nature, asbestos tape has proved admirable for this purpose. To reduce heat losses the whole assembly is covered by a high temperature resistant lagging material as used on boiler installations.

Material Feed

This device (5) controls the amount of material flowing into the heating cylinder at each shot. It is of the normal volumetric type and is controlled by the movement of the injection plunger (6), thereby giving a self-compensating effect. The base of the hopper is fitted with an adjustable gate (7) which in conjunction with a weir in the feed chute governs the flow of raw material.

The double shot mechanism which takes place during the normal cooling time has the effect of increasing the capacity of the machine to 6 oz. The use of this on normal weight mouldings also gives a form of pre-plasticizing.

Hydraulic Circuit

The machine is hydraulically operated throughout by one Vickers combination high and low pressure vane type pump (8), the cylinders operating the toggle and injection motions are controlled by pilot operated four-way valves. The pilot valves are solenoid operated and push-buttons are provided for manual operation. An additional solenoid valve permits the simultaneous use of full volume of combined high and low pressure to provide " boost " and to ensure continuous injection plunger speed and pressure. The hydraulic interlock, automatically opens the machine if the guards open. The base of the machine forms an oil tank (9) of 90–100 gallons capacity and is equipped with a water-cooled radiator.

SPECIFICATION

THERMOPLASTIC MATERIAL CAPACITY	
Hopper capacity	100 lb.
Volume moulded per shot ...	5 cu. in.
†Weight moulded per shot (additional up to 6 oz. with double shot)	4 oz.
*Plasticizing capacity per hour ...	50 lb.
INJECTION UNIT	
Diameter of injection plunger ...	2 in.
Injection pressure (variable) ...	18,000 lb. per sq. in.
Total injection pressure ...	56,700 lb.
Stroke of injection plunger ...	8½ in.

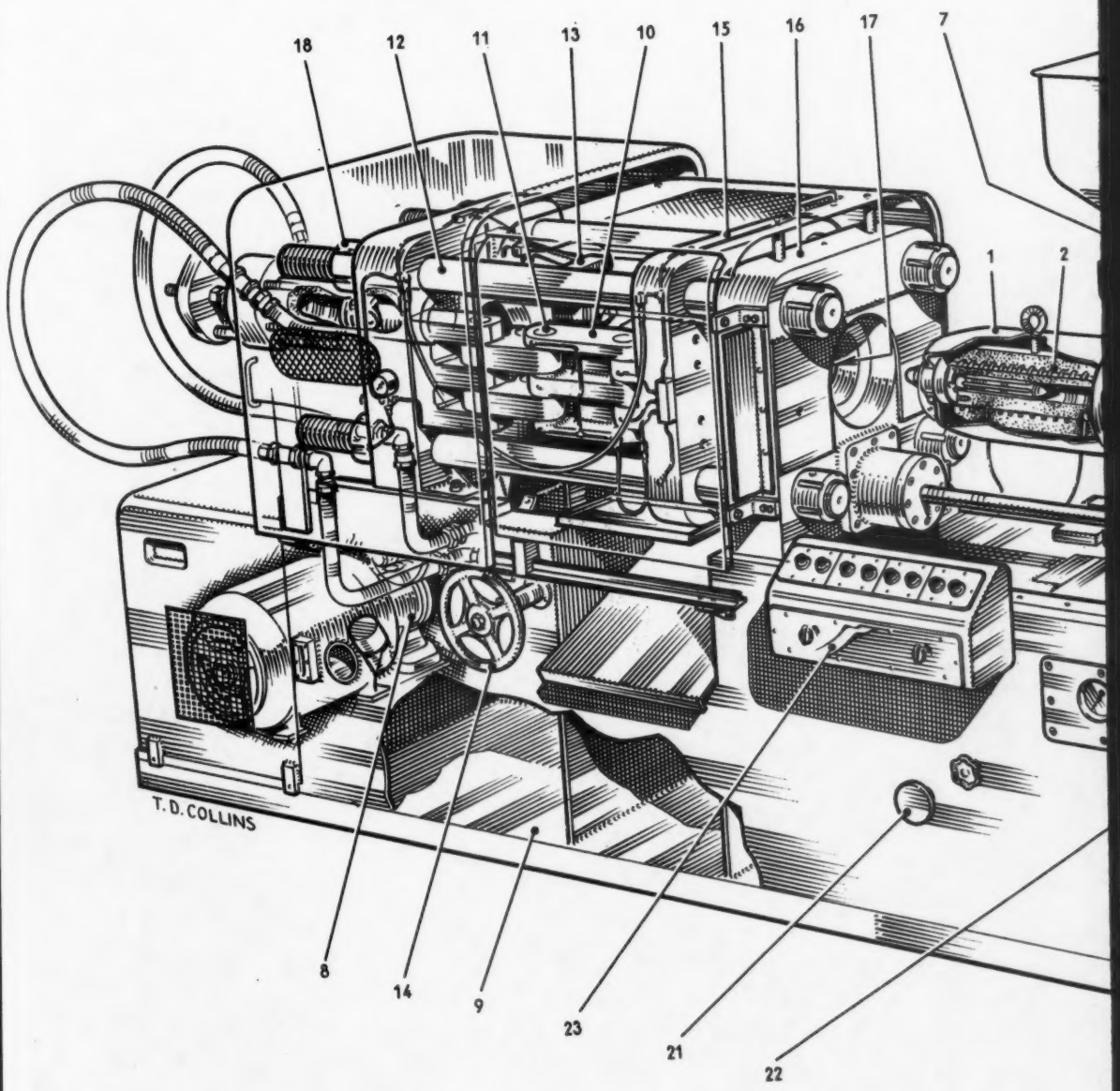
*Dependent upon product and mould construction.
†Double shot mechanism furnished as standard equipment.

Fig. 1. The Herbert/Reed-Prentice 4-oz. injection moulding machine.

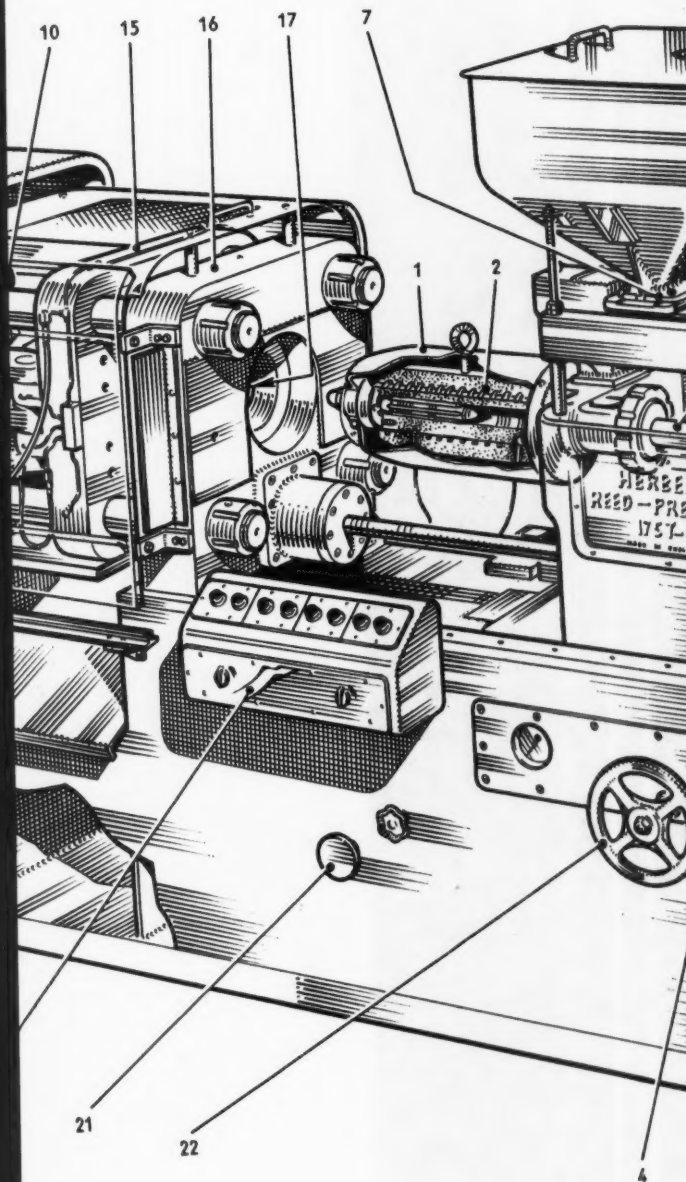
Toggle Mechanism

Mould locking toggle mechanism (10) is of double shear link type constructed of cast steel members with special alloy steel toggle pins (11), operating in hardened steel bushes which are automatically lubricated. The mechanism provides for a positive locking to the die plates of 175 tons. An automatic lubricator hydraulically operated ensures that at every cycle a measured quantity of oil is delivered to each moving part including toggle pins, tie rods (12) and cross head guides (13). A hand-operated stop valve (14) controls the speed of die plate movement.

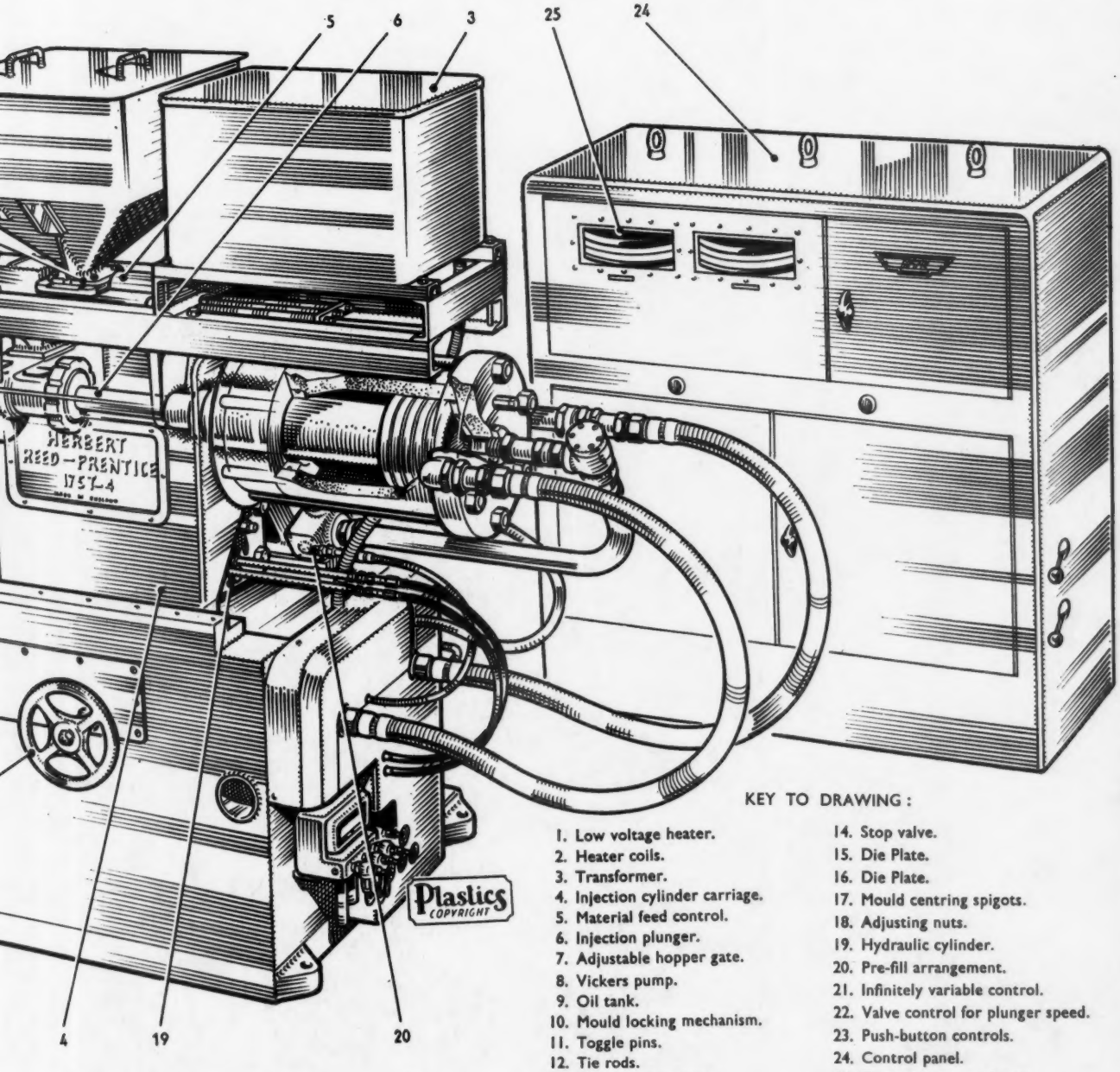
Herbert/Reed-Prentice 175T 4-oz



rentice 175T 4-oz. INJ

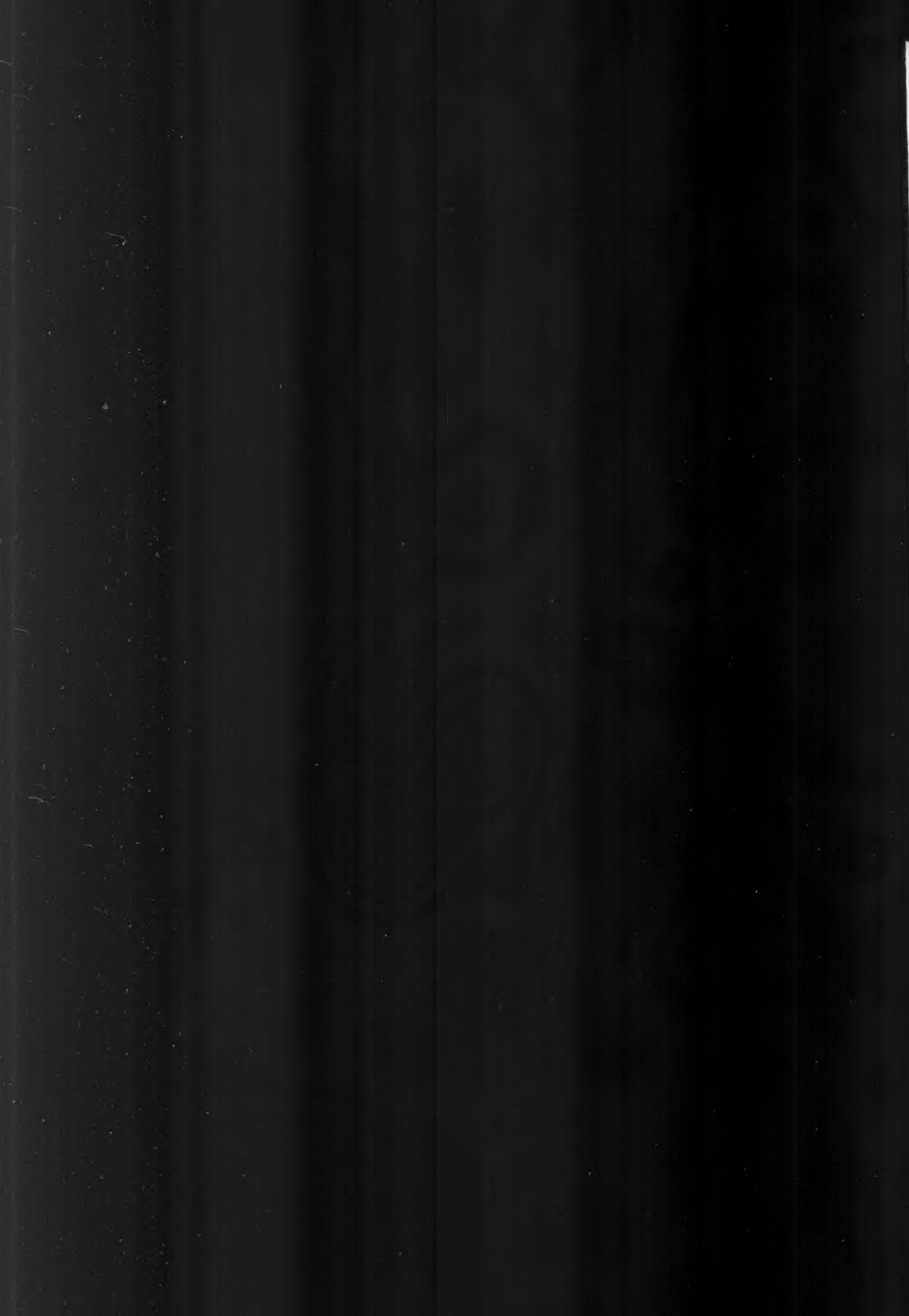


INJECTION MOULDING MACHINE



KEY TO DRAWING :

1. Low voltage heater.
2. Heater coils.
3. Transformer.
4. Injection cylinder carriage.
5. Material feed control.
6. Injection plunger.
7. Adjustable hopper gate.
8. Vickers pump.
9. Oil tank.
10. Mould locking mechanism.
11. Toggle pins.
12. Tie rods.
13. Cross head guides.
14. Stop valve.
15. Die Plate.
16. Die Plate.
17. Mould centring spigots.
18. Adjusting nuts.
19. Hydraulic cylinder.
20. Pre-fill arrangement.
21. Infinitely variable control.
22. Valve control for plunger speed.
23. Push-button controls.
24. Control panel.
25. Temperature regulators.



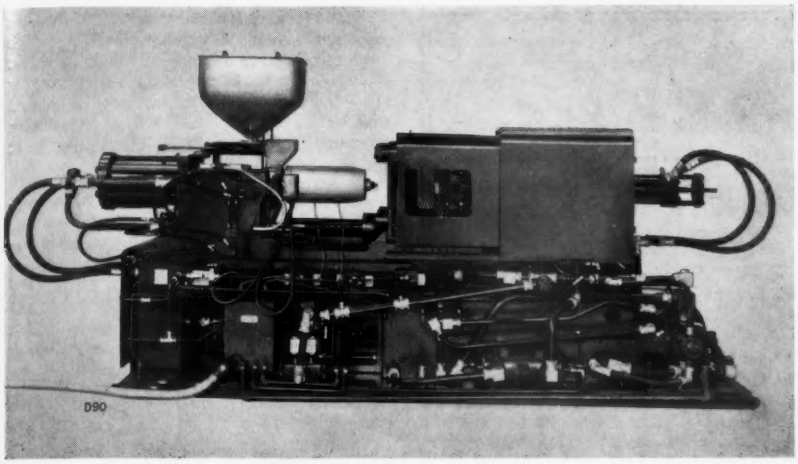


Fig. 2. View of rear of machine, with all panelling removed, showing piping, etc.

Die Plates

These (15, 16) are of steel and provided with bronze bearings for the tie bars. Both plates have drilled and tapped holes arranged in accordance with the die makers' recommendation, to ensure best clamping facilities for the mould. The insert centring ring in the stationary plate can be replaced to accommodate various sizes of mould centring spigots (17). The entire toggle mechanism is adjustable through a hand-operated rack and pinion, to permit accurate setting up and adjustment for mould thickness. Graduated and slotted adjusting nuts (18) on the tie bars provide individual adjustment.

Injection Unit

The movement of the entire unit is controlled by a hydraulic cylinder (19). This pressure maintains the nozzle in correct contact with the sprue bush, and for purging the whole unit is fully retracted. The movement of the injection plunger is controlled by a pre-fill arrangement (20) to give fast plunger speed, and an infinitely variable control (21) is provided for injection pressure and a valve (22) is fitted to control the actual plunger speed.

Control Panel

All operating push-buttons (23) together with the pump motor control and water-cooling valves are centralized to ensure convenient operation. These controls are so arranged that the machine may be operated manually, semi- or fully-automatically as desired. For semi- or fully-automatic operation, the control is by four electronic timing units. These units can be varied to suit individual jobs and controls: (1) the time the injection plunger maintains pressure on the material; (2) the time allowed for solidifying the material in the mould after the plunger has returned; (3) the time the mould remains open for the ejection of the finished moulding; and (4) the time the pump boost is in operation. The whole sequence of operations is continuous when the machine is operated fully automatically. When operated semi-automatically (i.e. single cycle), the mould is closed by operating the die closed push-button, and the cycle is then continued automatically by the timers. For manual operation, the movement of the die plates and injection plunger are controlled by push-buttons.

Low Pressure Mould Closing Device

As an extra feature all "Reeds" can be equipped with a low pressure die closing attachment, which assures positive mould protection. If a moulded part fails to eject automatically the machine stops instantly. In operation clamping pressure is applied gradually until the mould faces touch whereupon full pressure becomes effective to lock the mould halves together, should the mould faces fail to touch, due to any interference then full pressure is not developed, die movement stops and a warning bell is sounded. To accomplish this a solenoid operated valve in conjunction with a pressure relief valve and pressure switch, are added to the hydraulic system.

Electrical Controls

All electrical components on the machine are wired back to a junction box at the rear of the machine and the wiring taken from this common point via a flexible conduit to a separate floor mounting control panel (24). The unit can, therefore, be conveniently positioned to suit the particular installation.

Housed within this panel are the temperature regulators (25), timers, control relays and an automatic Star/Delta contactor starter for controlling the 15 h.p. hydraulic pump motor.

The temperature regulators have large clear dials and are easily read from a distance. Two instruments are provided each one controlling a zone of the heating cylinder.

Relays and contactors are of unit construction thereby facilitating quick removal and ease of maintenance. All wiring is neatly arranged in front of board manner. Fused isolators are included in the panel for both heater and control circuits and are interlocked with the door to prevent access to the interior unless switched off.

Machines are normally arranged for a 400/440 volt, three-phase, 50 cycles, four-wire supply but can be provided to suit any clients' particular supply.

Conclusion

Since its inception, this machine has been very well received both in America and in this country, and is being used to produce an indefinite variety of articles. It combines ease of operation with versatility and efficiency.

We acknowledge with thanks the co-operation of Alfred Herbert Ltd., in the preparation of this report.

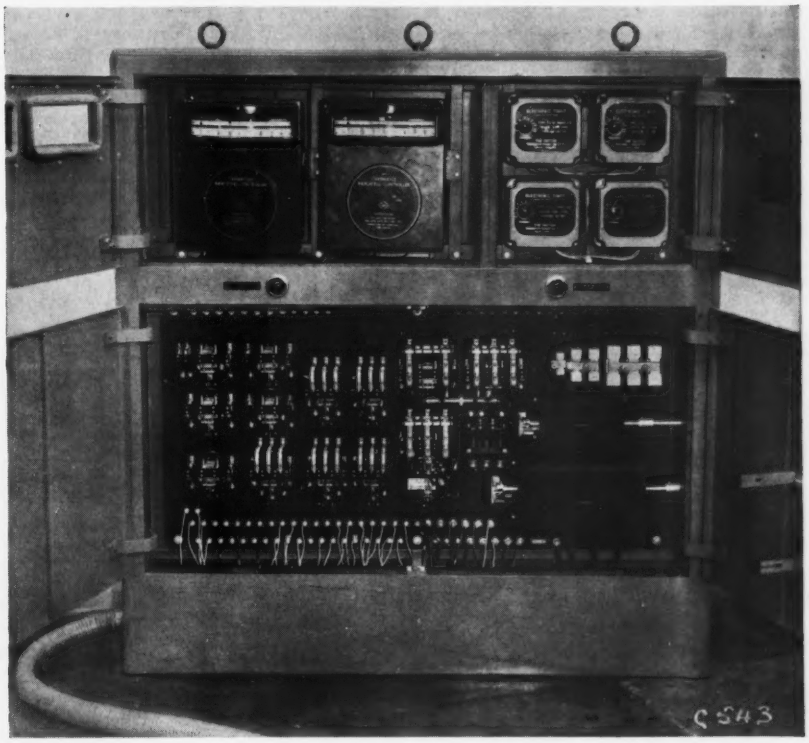


Fig. 3. Control panel with doors open, to show accessibility of instruments.

Plastics News

Plant and Equipment, Materials, Processes, Company News, Technical Literature, Exhibitions, Personal Notes and Meetings.

INJECTION MOULD HEATING UNIT.—B.I.P. Tools Ltd. are now producing an injection mould heating unit designed exclusively for convenient attachment to any injection mould. This portable water heating unit is a valuable asset in any thermoplastic moulding shop.

It can be engaged to develop the desired mould temperature prior to moulding and obviates the practice of mould heating by a preliminary run of scrap "shots."

It will maintain temperature on a mould which dissipates heat faster than the plastic charge can provide it.

General

Russian Tyre Plant.—The announcement was made last month of a further £5 million contract from Russia for the plant and equipment for a new tyre factory. The latest group of orders cover pneumatic handling and weighing equipment, impregnation plant, rubber processing plant and the associated equipment. The supply of this plant has been undertaken by the following companies: David Bridge & Co., Ltd., and Francis Shaw & Co., Ltd., for rubber processing plant; Mather & Platt Ltd., for impregnation and dipping processing lines; Simon Handling Engineers Ltd. for pneumatic weighing and handling equipment; Geo. W. King Ltd., for conveyors and automatic handling equipment. Electrical plant and control gear is being supplied by Crompton Parkinson Ltd. and Lancashire Dynamo Holdings Ltd.

Adhesives for Plastic Laminates.—Two new animal glues have been introduced by Bardens (Bury) Ltd., Hollins Vale, Bury, Lancs. These are known as Calbar R.3, a quick setting cold liquid skin glue for cold pressing and Symplast, a thermosetting glue for hot press work. Both types of glue have been tested extensively in the bonding of decorative laminates to plywood and other similar surfaces with excellent results.

Phenolic Moulding Compound.—Durez 18683 is a new low-cost impact phenolic moulding compound being introduced by the Durez Plastics Division of Hooker Electrochemical Co., North Tonawanda, N.Y. A sisal-filled, two-stage compound in nodular form, Durez 18683 is designed for applications which require a long flow, good water resistance, and a glossy finish under low pressure moulding conditions.

Durez compounds are handled in the U.K. by Omni (London) Ltd., 35 Dover Street, London, W.1.

Machining of Thermosetting Laminated Plastics.—A handbook intended as a code of practice for the designer and user of parts machined from laminated plastics sheet, tubing, rod and moulded sections—and in particular from laminates having a paper, woven fabric, or wood veneer filler—has been prepared by the British Plastics Federation. Materials specified in British Standards 1314, 1885 and 2572, are typical. Two classes of tolerances are set out which the fabricator members of the Federation find to be practical and reasonable.

The handbook is entitled "Tolerances for the Machining of Thermosetting Laminated Plastics" and is obtainable from the British Plastics Federation, 47/48 Piccadilly, W.1, price 2s. 6d., post free.

Automatic Down-Feed for Vertical Miller.—To increase the field of application of the Herbert 47V Vertical Milling Machine, the spindle head can now be fitted with an automatic power down-feed unit. This new unit permits any combination of holes in the vertical plane and at five levels, to be drilled and accurately bored during the same setting as for the milling operations.

Titanium Pigment Price Reduction.—With effect from 1st March, 1958, the price schedule of Titanium pigments manufactured by British Titan Products Co., Ltd., has been revised and the prices of the principal grades reduced.

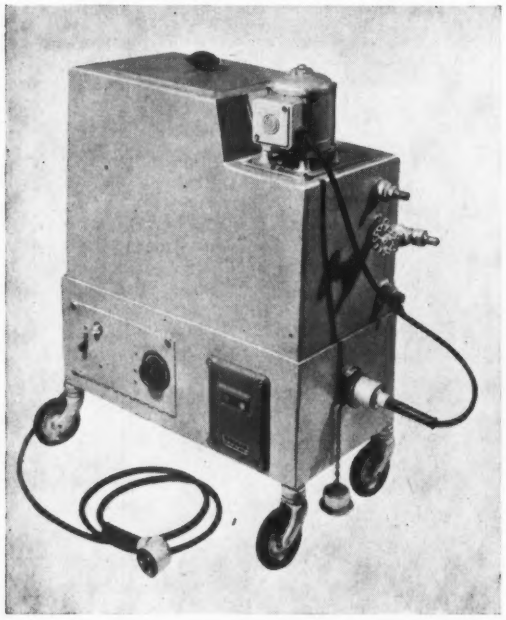
Silk Screen Printing Machine.—The New Dawson 3-Way is a silk screen printing machine which will print three different ways in one unit. It will print on round or tapered objects, such as bottles, tumblers, jars, cans, etc., square bottles, boxes, tins, etc., and flat surfaces such as street and traffic signs, show cards, clock and gauge dials, etc. In round printing the screen moves backwards and forwards over the objects being printed whilst the squeegee remains stationary lightly touching the screen. In square and flat printing the squeegee moves backwards and forwards pressing lightly on the stationary screen. The mechanical arrangement which provides this backwards and forwards movement is fully protected by British and Foreign patents.

Adjustment from one printing operation to another is a simple process which takes only a few minutes.

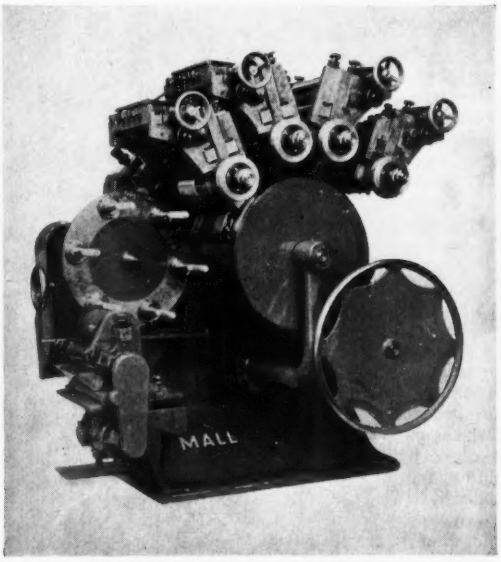
Further details are available from Dawson Bros. Ltd., Ventnor Works, Gomersal, Nr. Leeds.

Polyether Foam.—As a result of extensive research and development work in the United Kingdom and United States, Dunlop scientists have produced a new type of synthetic foam.

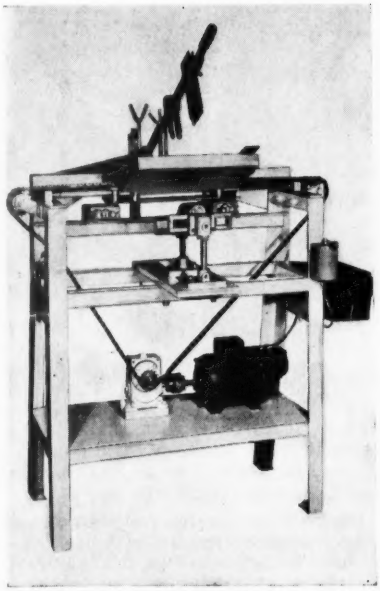
The new product, which will be compli-



(Left) The injection mould temperature control unit now being produced by B.I.P. Tools Ltd.



(Right) The Mall H.M.2 printing machine for cylindrical and conical containers. The U.K. representatives are Pearson Panke Ltd.



The Dawson three-way silk screen printing machine.

mentary to Dunlopillo latex foam and the Company's existing synthetic foam known as Dunloprene, is mainly derived from polyethers and diisocyanates, raw materials obtainable from the petroleum and coal tar industries. In addition to having a pleasant appearance, it has the soft springy feel associated with rubber and its resistance to chemicals and to ageing and weathering are likely to prove fundamentally superior. Its physical properties represent a considerable advance over those of Dunloprene on account of the more chemically stable polyether component and the closer control that can be exercized over the prepolymer manufacture.

Price Reduction.—Midland Silicones Ltd., have announced substantial reductions in the home trade prices of their MS 200 silicone fluids and their Releasil fluid.

Die Set Drawings.—Desoutter Bros. Ltd., have produced the first of a series of printed full scale outline drawings covering the range of their most popular standardized die sets.

The purpose of this scheme is to assist the speed up of drawing production in Jig and Tool Drawing Offices. After a press tool drawing has been completed, the draughtsman has merely to select the most suitable Die Set shape, position it under his drawing and trace off. Alternatively, the Die Set shape may be traced first and the press tool design draughted within the shape.

Full sets may be obtained, free of charge, from Desoutter Bros., Ltd., 121, Hay Lane, Kingsbury, N.W.9.

Plasticizer for Vinyl and Other Resins.—NTP is a plasticizer for vinyl resins and has the merits of low volatility, high flame resistance, non-toxicity, and high solvating power. It is therefore particularly suitable for use in food wrappings, toys, upholstery, clothing, etc. NTP gives compositions having good surface hardness and abrasion resistance, and it is not readily extracted by water or chemicals. In view of its high viscosity at low temperatures, NTP is generally used with other plasticizers.

Experiments carried out with NTP have shown that when administered in five successive doses each of 500 mg/kg to chickens, no toxic symptoms develop. Further experiments with 5,000 mg/kg on five successive days also showed no clinical effects. Long term experiments with daily doses of 50 mg/kg have been in progress for over six months and these have shown that there are no toxic effects. This programme is being continued. On rats, a single dose of 10,000 mg/kg also caused no toxic symptoms.

Full details of the plasticizer are available on request to Albright & Wilson Ltd., 1 Knightsbridge, London, S.W.1.

Hydrocarbon Wax.—A new hydrocarbon is being produced in the Sasolburg Refinery of the South African Coal, Oil and Gas Corporation, by the Fischer Tropsch process.

Sasolwax is a product which combines certain of the qualities of both conventional petroleum type paraffin wax and petroleum microcrystalline wax. It is composed of straight chain paraffin hydro-carbons, with an average molecular weight of about 750.

The characteristics of Sasolwax, are reported as showing good results in the plastic and rubber industries, as an additive for such purposes as lubrication, mould release, toughening, gloss and surface finishing. Additionally, tests have shown that improvement can be obtained on moisture vapour transmission by the use of wax of this type in the plastics field.

Additions of up to 20% into polythene are reported as showing improvements in tensile strength, stiffness, gloss and permeability. Furthermore, the wax raises the melting index of polyethylene enabling faster moulding cycles and low moulding temperatures. Further information on this material is available from Industrial Raw Materials Corporation Ltd., 2 Raymond Buildings, Grays Inn, London, W.C.1.

Lightweight Polyurethane Foam.—Leslie Gordon Ltd., 16 Tooks Court, Cursitor Street, Chancery Lane, London, E.C.4, announce that their principals in Germany have perfected a technique of foaming an extremely lightweight polyurethane foam material. This material is marketed under the name of Molti 1L Quality, and has a specific weight of only 0.018–0.020. Hitherto, polyurethane foam was only available in densities from about 0.028.

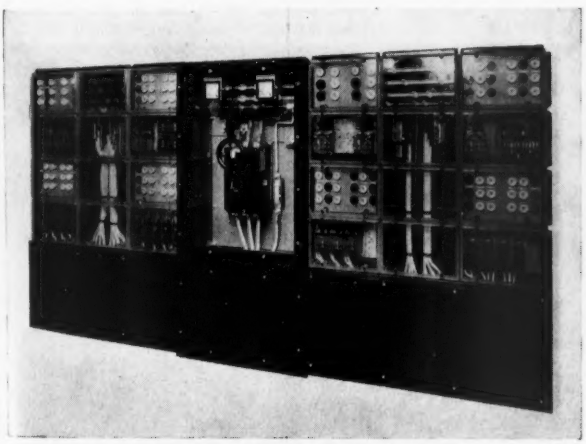
Whilst the manufacturers are still making a very extensive market research for the potential applications of this new foam, it was already very favourably received in the Packaging Industry as well as in the fields of heat and sound insulation.

On account of its extremely low density Molti 1L is very cheap and is unsuitable for a number of other trades such as Bedding and Upholstery Trades or for such domestic articles as sponges, mops, etc. The resilience of Molti 1L is much lower than that of polyurethane foams of higher density but on the other hand its thermal insulation properties are far better. It cannot, however, be used for thermal insulation under pressure as its very high insulating properties only apply when the foam is not compressed.

Exhibitions

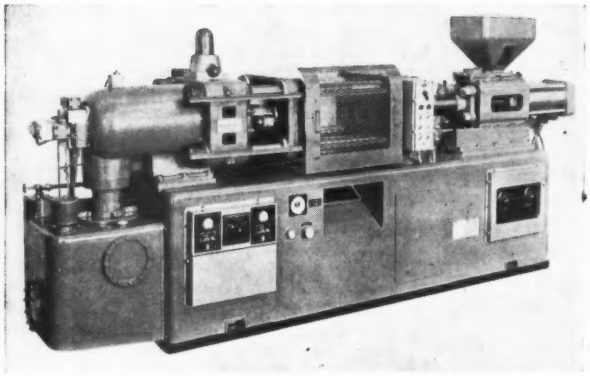
Brussels Exhibition.—Some indication of how plastics are being incorporated in the actual structure of the Brussels exhibition, at least so far as the United Kingdom area is concerned, can be gleaned from the report of just one organization.

The boating lake, 1,500 square yards in area, which is to be a feature in the British section, is being completely lined with plastic sheet. This is .014 in. blue, unembossed, non-laminated sheet of which some 2,000 square yards have been supplied by The Marley Tile Company.

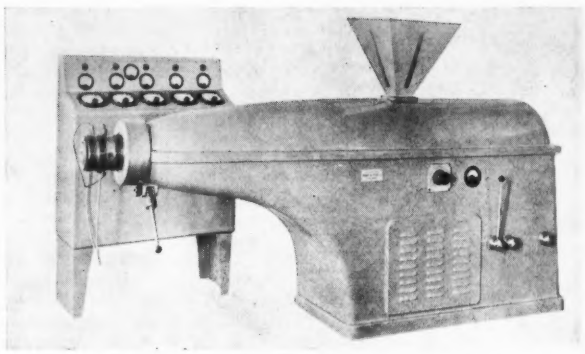


A moulded unit type switchboard with transparent covers being produced by Klockner Moeller (England) Ltd.

The stand of Ekco Plastics at this year's Hardware Trade Fair.



The Negri Bossi fully-automatic Rapid R/12/FA injection moulding machine shown at Milan.



The NB/90 Extruder, also shown by Negri Bossi at Milan.

This is being welded by Stephens (Plastics) Ltd., Corsham, Wilts., who have to contend with over a mile of welding, and 350 yards of junctions in the gulleys, etc.

For the "Crystalline Hall," architect Howard V. Lobb, C.B.E., F.R.I.B.A., has selected Marleyflex Floor tiles. The Hall of Tradition has these vinyl asbestos tiles, while special Marleyflex De Luxe Terrazzo tiles, in two shades of blue, have been made to cover the 400-odd square yards of the Hall of Achievement.

In the British Industries Pavilion, Marleyflex floor tiles, Marleyrail—a vinyl plastic handrail and Marleydecor, vinyl surfacing material are used extensively.

Milan Fair.—One of the companies exhibiting at the 1958 Milan Fair this month is Negri Bossi & Co. They are showing several new machines for the injection moulding and extrusion of plastic materials and include in their display a bottle blowing machine, pelleting equipment and vacuum forming machinery. Of the new injection moulding machines shown there is the NB/30 Record which completes their range of semi-automatic fast operating small machines. A completely new range designated the E Range has been introduced, and these injection moulding machines are self-contained and operate on an oleodynamic system, with the head stock and injection unit sliding on a cradle. The fully automatic presses, the prototypes of which were shown in New York, London and Amsterdam, are now in production and four models having capacities of 30 grams, 85 grams, 165 grams and 220 grams are on show. Some of the injection presses exhibited are fitted with automatic double feed mechanism giving increased capacity without reducing the work cycle.

Besides injection machines Negri Bossi are showing the complete range of NB Master extruders. These machines have a screw ratio of 18 : 1 and are available in two types, one having the drive through a gearbox and the other with a continuous speed variator incorporated in the motor. Ancillary equipment for the extruders is also exhibited.

Company News

Bakelite Ltd.—The following preliminary figures for the year ended December 31, 1957, have been issued. Group profit after charging depreciation, etc., was £431,022. A final dividend of 10% is proposed.

P. B. Cow & Co., Ltd.—The directors of P. B. Cow & Co., Ltd., recommend a final dividend of 5% on the ordinary stock making a total of 10% for the year. Group trading profit before taxation for 1957 was £338,080 slightly lower than for 1956.

The American Cyanamid Co. has formed a new division, Cyanamid International, for the purpose of making its products "more available" in Britain and other European markets. Consideration is being given to the building of additional manufacturing plants in certain countries where market conditions and other factors appear favourable.

Robert McArd & Co., Ltd., declared a final dividend of 25% less tax for the year ended 31 December, 1957. Profits for the year were down £10,000 on 1956.

Asmidar Plastic Moulding Machines Ltd., have moved to new premises at 116 Victoria Street, London, S.W.1.

Cinema-Television Ltd., have changed their name to Rank Cintel Ltd.

BTR Industries has concluded a licensing agreement with Tube Turns Plastics Inc., of Louisville, Kentucky, U.S., for the manufacture in the U.K. of unplasticized polyvinyl chloride pipe fittings, valves and custom moulded parts by the Hendry process.

Imperial Chemical Industries Ltd., have declared their intention, subject to the expected development of the market, to establish a unit in Northern Ireland for the spinning of Terylene polyester fibre. The planning and construction of the plant will take several years to complete, but it is hoped that it will be possible to start production by 1963–64.

Bakelite Ltd. announce that their production of Polyester Resins will be very considerably increased as from April, 1958, by bringing into operation additional units of plant.

This is in sharp contrast to the recently announced withdrawal from the polyester resin field of their American associates, and is, no doubt, explained by the differing market conditions in the two countries.

Thomas De La Rue & Co., Ltd., announce the start of operations by their Australian subsidiary, **Thomas De La Rue (Aust.) Pty., Ltd.,** which was formed with a capital of £A1,000,000 in June, 1956, for the manufacture of Formica laminated plastics.

The opening ceremony was performed on Friday, 14 March, by the Rt. Hon. R. G. Menzies, C.H., Prime Minister of Australia, at the Company's site at Thornleigh near Sydney.

It is the Company's intention that ownership of this factory should eventually be transferred to Formica Ltd., the De La Rue subsidiary in which the American Cyanamid Company has a minority shareholding.

Electricity Meter and Allied Industries Ltd., of Australia (Email Ltd.), have agreed to take up a substantial shareholding in the new Company and will be represented on the Board.

Omni Products Corporation have been appointed the Export Sales Representatives of the Aetna Electronic Corporation of Long Island, U.S.A., for the sale of their electronic treater for polyethylene film, enabling printing

Viscount Chandos, Sir Gordon Radley, and Dr. Aldington, in conversation after the Siemens Bros. Centenary Lecture. In the foreground is a piece of radio-telephone speech inversion equipment.

Mr. H. F. Wilson.

Mr. C. L. G. Fairfield.

Mr. D. A. Hubbard.

to be carried out much more simply than hitherto.

All inquiries concerning these machines for use in the United Kingdom should be addressed to Engineering Department, Omni (London) Ltd., 35 Dover Street, London, W.1.

Semtex Ltd.—A training scheme for young men interested in a career in the technology of rubber and plastics is to be established at the Brynmawr factory of Semtex Ltd. It will cover young men from 16 to 18 who are interested in practical science.

Erinoid Ltd. will be moving their London Sales Office, on April 13, to West Halkin House, West Halkin Street, Belgrave Square, London, S.W.1.

The Geigy Co., Ltd., announce the recent completion of extensions to their plant at Trafford Park, Manchester, which will mean a 40% production increase in sebacic acid.

George Cohen, Sons & Co., Ltd., Raw Materials Division, has moved to Trinity Road, Kingsbury, Tamworth, Staffs.

Personalities

Sir Bernard Waley-Cohen has joined the board of O. & M. Kleemann Ltd.

Telcon Appointments.—The Directors of The Telegraph Construction & Maintenance Co., Ltd., announce the appointment to the Board of **Mr. H. F. Wilson** and **Mr. C. L. G. Fairfield.**

Mr. Wilson will presently assume the appointment of Managing Director of the Telcon Cables Group. He joined The Telegraph Construction & Maintenance Co., Ltd., in 1919, and was appointed Chief Chemist in 1945 and Technical Manager in 1948. Mr. Wilson subsequently headed the Company's Plastics Division when it was reformed in 1953 as a separate unit at Farnborough Works, Kent. In 1956 he was also appointed Works Manager of the Cable Factory at Greenwich, and ultimately Assistant Managing Director of the Telcon Cables Group in 1957. He is also a director of several Telcon subsidiary and associated companies.

Mr. Wilson is a prominent member in the field of plastics, and in 1953/55 was Chairman of the Council of The Plastics Institute.

Mr. C. L. G. Fairfield, who has been appointed Commercial Director of The Telegraph Construction & Maintenance Co., Ltd., joined the Company in April, 1953, as Manager of the Overseas Division, and was soon appointed General Sales Manager for the Company and Submarine Cables Ltd. He is a director of Telcon Enterprises Overseas Ltd., and Toolpro Ltd.—two subsidiaries of the Telcon Group of companies.

Mr. R. J. Ballard has been appointed Sales Manager, Domestic Division of Creators Ltd. Mr. Ballard has taken over from Mr. D. I. Shakespeare, who has now resigned his post with the Company.

Mr. D. A. Hubbard has been appointed a director of Aero Research Ltd. Mr. Hubbard joined Aero Research Ltd. in 1939 and shortly afterwards took charge of production. In 1947, he was appointed Works Manager with special responsibility for the planning and commissioning of the large-scale production plants which have been erected at Duxford since that time.

Mr. R. L. Paice, who has been sales director of Igranic Electric Co., Ltd., Bedford, since 1948, has relinquished this position. **Mr. A. W. Page,** as sales manager, will be responsible for the Home and Export Sales Organization.

Mr. Paice as a Director of the Company will carry out special assignments of the Board.

Dr. W. H. Garrett, director of Monsanto Chemicals Ltd., has been elected president of the British Employers Confederation in succession to Sir Colin Anderson.

Mr. B. J. Hersey.—George Ellison Ltd. announce the appointment of Mr. B. J. Hersey as Technical Engineer responsible for the sales and consultative service for Ellison Hydraulic Valves in the South of England and South Wales.

Mr. S. A. Comley.—To deal with increasing tool steel business in London and the Home Counties, Uddeholm Ltd., the British associates of Uddeholms AB, have appointed Mr. S. A. Comley as London Area Manager, Tool Steel Division.

Mr. A. R. Crew.—At a recent council meeting of The Incorporated Advertising Managers' Association, Mr. A. R. Crew, advertising manager of Monsanto Chemicals Ltd. was elected a Fellow of the Association.

Mr. H. T. Eatwell.—It is with regret that we hear of the death of Mr. H. T. Eatwell. Mr. Eatwell was the managing director and joint deputy chairman, of G. A. Harvey & Co. (London) Ltd.

After opening the O.C.C.A. Exhibition at the Horticultural Hall, Westminster, on March 12, Sir Walter Worboys, I.C.I. Commercial Director, examines silicone exhibits on the Stand of I.C.I. Nobel Division.

Meetings

April

10th.—" Synthetics and the Motor Car," by D. G. Clark. The Scottish Section of the Plastics Institute, at More's Hotel, Glasgow. 7.30 p.m.

16th.—The Annual General Meeting of the North-Eastern Section of the Plastics Institute, the Second Dining Room of the Eldon Grill, Grey Street, Newcastle. 7 p.m.

16th.—" Plastics in Relationship to Other Engineering Materials," by E. W. Russell. The Western Section of the Plastics Institute. 7 p.m.

18th.—" Marketing Methods," by A. W. Sherwood. The Midlands Section of the Plastics Institute, the James Watt Memorial Institute, Great Charles Street, Birmingham, 3. 6.30 p.m.

18th.—" The Scientific Measurement of Temperature," by J. A. Hall. The North-Western Section of the Plastics Institute, the Engineers' Club, Albert Square, Manchester. 6.45 p.m.

28th.—Annual Luncheon of the Midlands Section of the Plastics Institute, at the Queen's Hotel, Birmingham.

May

1st.—" Peroxides in the Curing of Polyester Finishes," by P. R. A. Maltha and L. W. J. Damen. The Birmingham Paint, Varnish and Lacquer Club, the Imperial Hotel, Birmingham. 6.30 p.m.

6th.—" Modern Ideas on Polymer Formation and Degradation," by N. J. L. Megson. The London Section of the Plastics Institute, the Wellcome Building, 183–193 Euston Road, London, N.W.1. 6.30 p.m.

7th.—The Annual General Meeting of the Yorkshire Section of the Plastics Institute, St. Marks House, 186 Woodhouse Lane, Leeds.

13th.—" Reactions Induced Mechanically in Polymer Systems," by Dr. W. F. Watson. The Plastics and Polymer Group of the Society of Chemical Industry, S.C.I. Meeting Room, 14 Belgrave Square, London, S.W.1. 6.30 p.m.

Automation Equipment

Automatic Controller Failure Indication. (British Patent No. 779267.)—Potentiometric Temperature Indicators, Recorders and Controllers, compare unfavourably with the deflectional type of measuring instruments inasmuch as that in the latter a break in the signal input circuit permits the return of the pointer or pen to its normal zero position where, by various means already well known, it can be made to indicate or signal that there has been a circuit failure. In the case of the potentiometric type of instrument, however, when the input signal fails to get through or the instrument fails to respond to a signal due, either to electrical or mechanical faults, the indication of the measured variable remains stable at the point of balance existing immediately prior to the occurrence of the fault. It is true that broken-couple alarm action can be applied to any potentiometric instrument, but this presupposes that the instrument is itself capable of responding to the broken thermocouple signal.

The new Foster Automatic Controller Failure Signal and Safety Unit now provides a mechanism that automatically and periodically checks the functioning of potentiometric self-balancing controllers by sending through the signal generating, measuring and balancing system a periodic test signal which, if it fails to get through due to any electrical or mechanical fault in the system, causes a warning signal to be given and, if required, automatic shut-down of safeguarding action to be taken.

The frequency and strength of the test signal can be set to suit the " run-away " time of the controlled process and the balancing speed of the controller. The device is fitted with an alarm which functions should its own prime mover fail.

Foster Instrument Co. Ltd., Letchworth, Hertfordshire.

Electronic Hygrometer.—A new Hygrometer with an immediate response, stable characteristics and provision for easy checking and standardizing, as well as remote reading. The Hygrometer is essentially simple, robust and reliable.

The small detecting element consists of a capacitor with a hygroscopic dielectric, only a few microns thick, with a 24 carat gold electrode.

The detector is contained in a small, strong, fine wire gauze protector, which plugs into a coaxial cable connecting it to the recorder. The detecting element is 1 cm. in diameter and 6 cms. long, and can be used with any length of cable.

Unlike the old hair type instruments, the Shaw Hygrometer has a response time of a few seconds with a good long term stability, negligible temperature errors and hysteresis and can be checked and reset in a few seconds.

Shaw Moisture Meters, 31 Market Street, Bradford, England.

The new Shaw electronic hygrometer.

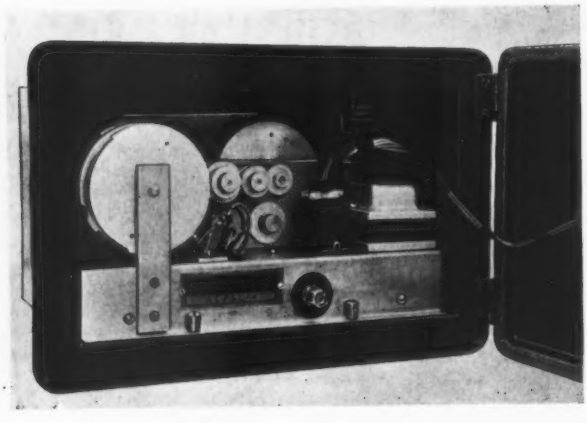
Fluoroscopic and Radiographic Cabinet.—Suitable for the direct visual examination of small objects by X-ray fluoroscopy, this new cabinet also has provision for radiography. The built-in inspection drawer is 12 in. square and 5 in. deep, and the cassette drawer, mounted directly above it, will take cassettes up to 12 in. × 10 in. in either orientation. The enclosed cabinet, which is lead-lined where necessary, provides full protection to the operator against direct and scattered radiation. Outputs up to 110 kVp 10 mA are available with water-cooling. All controls, which are simple to operate, are mounted on a sloping panel to the right of the fluoroscopic viewing hood.

Castored wheels can be fitted to the cabinet making it fully mobile and facilitating its use at different locations. Facilities are also provided for external radiography of components which are too large to fit the inspection drawer. This instrument will be shown at the Instruments, Electronics and Automation Exhibition to be held at Olympia from April 16 to April 25.

Marconi Instruments Limited, St. Albans, Hertfordshire, England.

(Right) The Marconi fluoroscopic and radiographic instrument for the direct visual examination of small objects.

(Below) The new automatic controller failure signal and safety unit introduced by Foster Instrument Co. Ltd.



TALKING SHOP . . .

25 Years of Golf. Every year the members of the Plastics Industry Golfing Society organize a dinner-dance at the Savoy Hotel, London. At this function, the charming and beautiful golf widows are to some extent mollified for the tedious hours they spend separated from their consorts. This year's party, on March 21, had special significance, for it was the Silver Jubilee of the " Pigs," and triumphantly in the chair was Cyril Last, captain of the Society since its foundation in 1933. Mrs. Last cut a magnificent birthday cake, Jack Urban made a speech, and we all sang " For they are jolly good fellows." Some photographs taken during the reception are printed below.

* * *

Change of Names. On May 1, 1958, the names of Dr. V. E. Yarsley (Research Laboratories) Ltd. and Dr. V. E. Yarsley (Plastics Testing Laboratories) Ltd. will be changed to Yarsley Research Laboratories Ltd. and Yarsley Testing Laboratories Ltd.

* * *

New Factory for Turner Brothers. Part of the Turner and Newall organization, Turner Brothers Asbestos Co., Ltd., have just opened a new block on the Hindley Green site, near Wigan. Now covering 140 acres, the site development is part of a £4m. development programme launched in 1947. Products at Hindley Green include rubber and p.v.c. belting, asbestos, Durestos (resinated asbestos), and glass fibres.

The history of the company dates back to 1871, and in 1878 it was the first to spin asbestos yarn in Britain. Today it has an unrivalled knowledge of asbestos and a major interest in the plastics industry.

* * *

Science and Technology in the U.S.A. Under the auspices of a Bruern Foundation Travelling Grant, Dr. J. Glazer has recently made a detailed tour of the U.S.A. and Canada. His impressions of high polymer science and technology in North America are being serialized in *Plastics*, the first part of which appeared last month, pages 86–87. His comments have already aroused considerable interest in industrial circles, for the U.S. today poses a major question mark: has the scientific and industrial potential enough impetus to carry the nation's economy through the present recession ? Dr. Glazer examines in this issue (pages 126–128) one of America's major phenomena—the Mellon Institute, a non-profit making research organization, without parallel in Britain.

Dr. and Mrs. J. Glazer on their return from America.

City and Guilds. " In 1950 the Institute examined 74,000 candidates ; in 1957 that number had gone up to 120,000 candidates. This is obviously very encouraging for the Institute and for the nation as a whole, but it is most important just at this period of our history that nothing should hinder this number of candidates from increasing still further. As a nation we can never hope to make ends meet unless every person in industry is making the fullest and most rewarding use of his talents."

With these words, spoken at the ceremony of laying the first stone of the Institute's new headquarters in Portland Place, on February 18, His Royal Highness, Prince Philip, The Duke of Edinburgh, renewed the torch which the Institute has carried since its foundation 80 years ago. It was a call not only to those who work in and for the Institute but also to industry, to the technical colleges and schools, to craftsmen, technicians and technologists and, not least, to those who, leaving their school days behind them, join the great world of industry and commerce and become partners in a great enterprise.

* * *

J. H. Collins. For the last three years concerned with factory management at Permali Ltd., Mr. J. H. Collins has set up in practice as a consultant in plastics and related technologies. He graduated at Liverpool in 1933 in the honours school of chemistry, and until 1942 was in the general chemicals division of I.C.I., engaged on research, technical service, and plant construction and management. He then joined Erinoid Ltd., as chief chemist, being appointed production manager in 1953. Then followed a year with Dr. V. E. Yarsley (Research Laboratories) Ltd., after which he joined Permali. Mr. Collins has also functioned

Mr. J. H. Collins.

as honorary secretary of the Western Section of the Institute, and as visiting lecturer in plastics technology at Stroud Technical College. I wish him well in his new activities.

* * *

A.P.I. The Associateship of the Plastics Institute by examination has recently been recognized by The Burnham Committee as a degree equivalent qualification.

This announcement provides the opportunity to re-state briefly the essential features of the Institute Examination and the conditions under which the three main membership qualifications may be obtained. (Fuller details will be in the current Regulations.)

The Institute Examination : This is divided into four Groups : Group I, English, Plastics Technology (four papers) ; Group II, Organic Chemistry, Physical Chemistry ; Group III, Organic Chemistry of Plastics, Physical

The " Pigs " celebrate 25 years of golf. Seen here are Mr. and Mrs. Cyril Last and Mr. and Mrs. Arnold Sherwood.

(Left) Mr. and Mrs. T. L. Birrell at the reception.

(Right) Miss Edna Webb with Mr. and Mrs. Last.

Chemistry of Plastics, Advanced Plastics Technology (by paper or project); and Group IV, Industrial Administration.

Physicists and Engineering candidates may take appropriate alternative subjects in Groups II and III. Successful completion of Group I entitles a student to apply for the Diploma of the Institute. Exemption may be obtained from Groups I, II and IV by holders of approved exempting qualifications (e.g. an H.N.C. in Chemistry would exempt a candidate from Group II). There are no exemptions from Group III.

The Graduateship is awarded to candidates who satisfy the requirements of Groups I, II and III.

The Associateship is awarded to candidates who satisfy the requirements of Groups I, II, III and IV, who are not less than 25 years of age and who have had three years' technical experience in the plastics industry.

Alternatively, candidates whose technical experience and general education are deemed equivalent to the standard required for Groups I, II and IV may obtain the Associateship by submission of a satisfactory thesis or dissertation. Full details are available from the Institute at 6, Mandeville Place, London, W.1.

Swimming in comfort—the glass fibre pool designed for the ordinary garden.

The Quiet Revolution. The publicity department at B.X. Plastics have always been rather good at preparing booklets. The latest in the series, "The Quiet Revolution," was sparked off by C. M. Glover, the company's managing director. It is in the nature of a report for 1956–57, beautifully illustrated with photographs, and was designed primarily to be read by the employees. It highlights the increase in mechanization and the use of power and also shows the decline of the importance of cellulose derivatives in the company's business. In 1946 these materials were by far the most important, but in 1957 had fallen to a point when they constitute only one-fifth of the total production, having been replaced by newer materials.

Swimming Pools for Everyman. Landscape and Gardens (Wolverhampton) Ltd. recently arranged a demonstration of glass fibre swimming pools. Pigmented in pastel blue, they are made in various sizes, from the small 9 ft. × 5 ft. × 2 ft., to the family pool, 24 ft. × 10 ft. × 3 ft. Prices range from £65 to £335, and installation costs can be as low as £5. With a fine summer, the future for these pools should be bright. PLASTIKON.

American Developments

NEW POLYESTER PHOTO FILMS: RADAR BOARD FABRICATED IN CAST ACRYLIC

THE strength, transparency, and durability of its "Cronar" polyester film base have enabled Du Pont's Photo Products Department to develop three completely new photographic films for reproducing engineering designs, plans, and maps. Called "Cronflex" engineering reproduction films, they produce a positive copy of the same size as the original and are used where the negative step is not needed or desired. "Cronflex" contact film provides either negative or positive intermediates when reproduction to the same size is required. "Cronflex" projection film is used in process cameras and enlargers. As is the case with the other two films, the matte surface accepts notations with pen or pencil, and erasures and ferricyanide etching may be performed without smudging.

The new films have a decided advantage over paper, reproduction cloth, and conventional film. The chemical stability of "Cronflex" intermediates permits multiple reproduction printing through diazo and blueprint machines without deterioration of the image, and its thinness and transparency permit more and sharper reproductions per hour than is possible with reproduction cloth. Its physical durability makes possible longer printing runs than can be made with materials now in general use.

Since the base contains no plasticizer or other additive, "Cronflex" engineering reproduction films remain flexible long after most materials have become too brittle for use. Service and archival life, therefore, seems limited only by the manner in which the exposed film is processed and used.

Direct positive film may be exposed and processed under low-level tungsten illumination, while contact and projection films must be exposed and processed under photographic darkroom conditions.

WHAT is claimed to be the world's largest radar plotting board, designed and erected for the Air Defence Command, Colorado Springs, Colorado, by Brooks & Perkins, Inc., Detroit, consists of a single sheet of Plexiglas cast acrylic, 30 ft. long, 19 ft. wide and ½ in. thick. It was fabricated on the job site from eight 100-in. by 120-in. sheets, the largest thermoplastic sheets manufactured. The sheets were prepared with butt joints, and bonded with quick setting PS-18 cement. The bonds have excellent optical characteristics and are invisible under normal light. Under the strong edge lighting of the radar installation, the bonds show up as faint white streaks.

Edge lighting is provided by slimline fluorescent tubes mounted directly to all four edges of the giant sheet. Magnesium channel forms the framework of the installation and also conceals the edge lighting. Total weight of the panel, including magnesium frame, is 3,750 lb. The principal plotting board is flanked by four wing boards, ranging in size up to 19 ft. by 15 ft.

Radar plotting board 30 ft. x 19 ft., at U.S. Air Defence Command, Colorado.

To the barmaid who served him his beer
The regular said, Be a dear
You may think I've a cheek
But I would like a peek
At your new Polythene tubing which I am led to
understand can't affect the flavour of the
beer passing through it and is cheap to install
and is made by Lorival Plastics whose
lively lads have a penchant
for Polythene

In the process of
loading a load
A docker was heard
to explode
If the goods you
see stacked in
The hold had been packed in
Tough, economical, moisture-and-chemical-
proof PVC sheeting by Lorival they'd
reach customers in much better condition
and go quite a way to helping
our export problem.

A tycoon from
Texas, U.S.
Interviewed by a lass
from the Press
Said I've come here
my gal
To see Lorival
About their liquid rubber and
rubber compounds which are pourable at
room temperature and for which I can think
of an infinite variety of uses. Yes Ma'am!

A tailor regarded
with pride
A jacket with
vents at each side
With features aglow
He showed Savile Row
Who admired the colourful coat hanger
injection moulded by Lorival in cellulose
acetate upon which the aforementioned
sartorial chef d'oeuvre reposed.

L81

What's your line? We're sure that somehow, somewhere, Lorival plastics can play a part in it. Or perhaps you can think of a profitable use for our versatile liquid rubber and rubber compounds. Let's get together soon. We'll find a way of using Lorival's lively lads and resources to your advantage. Meanwhile, write or phone for an interesting batch of Lorival booklets.

LORIVAL PLASTICS

UNITED EBONITE & LORIVAL LTD., LITTLE LEVER, NR. BOLTON, LANCS. PHONE: FARNWORTH 676

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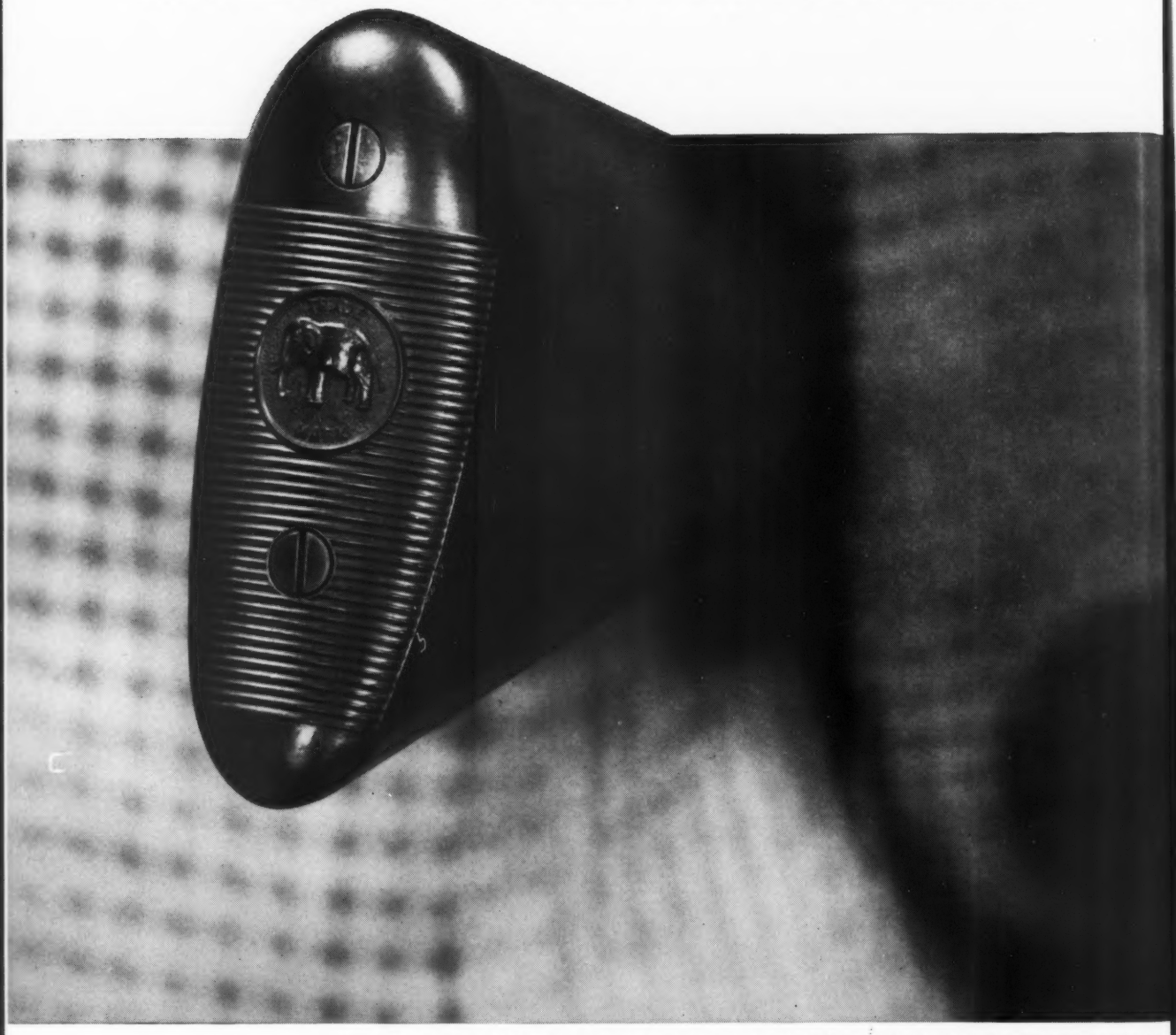
MOULDED IN LUSTREX FOR TOUGHNESS



Gun butt plate moulded in Lustrex T-11 for W. W. Greener Limited by Studio Plastic and Metal Components Ltd.

Lustrex polystyrene has grades for every purpose:

For toughness—and extra-toughness . . . Lustrex Toughened 3 and Toughened 11.

For vacuum-forming—Lustrex Toughened 6 for sheet extrusion.

For intricate mouldings—specially those needing a long flow . . . Lustrex Hi-Flow 55.

For dry colouring—to any shade you require . . . Lustrex Colourant Blend.

For almost any job in polystyrene . . . Lustrex General Purpose.

Lustrex is a Registered Trade Mark.

Monsanto Reg'd.

MONSANTO PLASTICS LIMITED,

411 Monsanto House, Victoria Street, London, S.W.1 and at Royal Exchange, Manchester, 2.

In association with: Monsanto Chemical Company, St. Louis, U.S.A. Monsanto Canada Limited, Montreal. Monsanto Chemicals (Australia) Ltd., Melbourne. Monsanto Chemicals of India Private Ltd., Bombay. Representatives in the world's principal cities.

Europe and Petroleum Chemicals

By P. N. COLLINSWOOD, B.Sc., C. F. M. MACKINTOSH, B.Sc.,* and H. STEINER, Ph.D.*

FOSTERED by a growing refining industry and by increased discoveries of natural gas, the petroleum-chemical industry in Western Europe continues to make striking gains. Demand is growing faster than planned capacity and upward revisions of plant capacity during construction are not uncommon.

A notable trend in the European chemical industry is the growing use of natural gas as a raw material, particularly in France and Italy where it is comparatively plentiful. Natural gas is also a primary material in Germany.

Table 1 below is based on OEEC figures:

TABLE 1
FEEDSTOCK FOR THE PETROLEUM-CHEMICAL INDUSTRY

	1954	1955	1956
	In long tons		
Liquid feedstock ..	681,000	751,000	866,100
Refinery gases ..	343,500	576,800	774,600
Natural gas ..	65,000	78,700	126,000

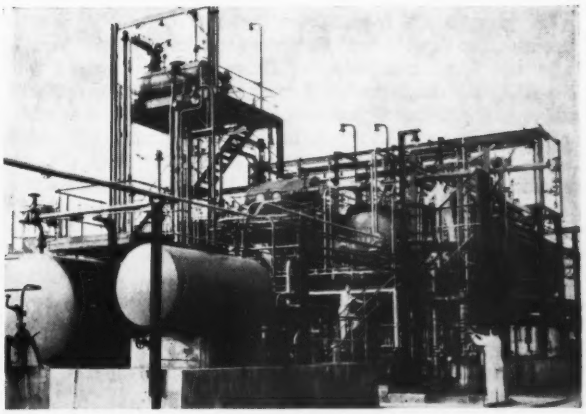
In its latest publication the Petroleum Chemicals Working Party of the Chemical Products Committee of the OEEC has reviewed petroleum-chemical production in 1956 and expansion plans to the end of 1959 (1). Capital investment in the industry since 1945 totalled $412 million at the end of 1956, an increase of $100 million over 1955. By the end of 1959 the OEEC expects the figure to climb to $1,073 million, equivalent to an increase of 160% in three years.

The new facilities will mean an increase in production to 1.2 million tons in 1960 (if expressed as carbon content of the finished chemicals) from 470,000 tons in 1956 and about 580,000 tons last year. Another source (2), presenting its figures as tonnages of finished or intermediate chemicals, states that the petroleum-chemical output of Western Europe was more than a million tons in 1956.

As in the United States the emphasis in Europe is on plans for ethylene. The major outlets for this product are ethylene oxide and polyethylene and in the U.K. additionally ethyl alcohol. At present ethylene oxide is the major consumer of ethylene, which in turn is used primarily in the manufacture of mono-ethylene glycol for anti-freeze, though production of polyester fibres and of synthetic detergents is consuming growing proportions.

For the production of ethylene oxide the direct oxidation of ethylene is now the favoured process in Europe, in general being preferred to chlorhydrination. Direct oxidation will be used to produce nearly all the 100,000 tons/year of new ethylene oxide capacity now planned for Europe. The scheduled production will nearly double the present output of ethylene oxide. Direct oxidation plants in France, Germany and Belgium are being built by the Scientific Design Company of New York, who first built a plant in France (since in production) and who have also been responsible for several U.S. plants.

However, the most spectacular expansions are predicted for polyethylene. Production in 1956 totalled 80,000 tons a year, but capacity in the coming two years is expected to reach 200,000 tons, rising another 100,000 tons by the end of 1962 (3). The



Tank storage at the copolymer plant at Newport of Monsanto Chemicals Ltd.

major part of the present capacity in Europe is based on I.C.I.'s high-pressure process, but future expansion will make increasing use of the low-pressure processes, notably the Ziegler process which was developed and first applied in Germany. Other plants using the Phillips low-pressure process are also being installed.

The work done by Montecatini in Italy on the polymerization of propylene is of great importance. Montecatini developed and was the first to produce polypropylene commercially and Hoechst has now followed with a plant of similar capacity. Hüls in Germany and Petrochemicals of England are known to be developing polypropylene and I.C.I. is thought to be interested in it.

Production of butyl and S.B.R. (formerly called G.R.S.) synthetic rubbers, so far in very limited production in Europe, will also receive much attention. Nearly all synthetic rubber consumed in Europe today (150,000 tons in 1956) is imported from Canada and the U.S. Synthetic rubber plants planned to go on stream in 1958–59 will just about equal that capacity. On the other hand European requirements are expected to be more than double in the next five years and it is very likely that the capacity for synthetic rubber will be increased further (3).

TABLE 2
EUROPEAN SYNTHETIC RUBBER PLANTS—S.B.R. (G.R.S.) TYPE

Country	*Producer*	*Site*	*Capacity in tons/year*	*Remarks*
U.K. ..	1. Intern. Synthetic Rubber Co., Ltd.	Fawley	50,000	Company formed by Dunlop, Goodyear, Firestone and Michelin. Cost of plant: £7–8 million. Completion late in 1958.
	2. Dunlop Rubber Co., Ltd.	Fort Dunlop	1,500–2,000	Pilot plant for above S.B.R. rubber production.
W. Germany	1. Buna Werke Hüls GmbH.	Marl	45,000–50,000	Plant expected to be in operation in 1958. Owned by Hüls (50%) and BASF, Bayer & Hoechst (16⅔% each).
	2. Chemische Werke Hüls AG.	Marl	10,000	Existing plant.
Italy ..	Azienda Nazionale Idrogenazione Combustibili SpA	Ravenna	55,000	Initial plant was 35,000 tons/year. Final completion 1959.
France ..	Societe du Caoutchouc Butyl (SOCABU)	Port Jérôme	40,000–50,000	Consortium formed by rubber and petroleum companies to produce butyl rubber. Now planning S.B.R. platt.
Netherlands	Shell Pernis Chemische Fabrieken	Pernis	50,000	Plans announced in 1958.

* Manchester Oil Refinery Ltd. The authors are indebted to Miss V. Skulan, of the same organization, for her assistance in preparing this report.

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The growth of the petroleum-chemical industry in Europe decreases the dependence of the area on imports, particularly from the U.S., and new petroleum-chemical capacity will emphasize this development. For example, imports of synthetic rubber and ethylene derivatives in particular will drop appreciably as present plans for production of these materials within Europe are completed. However, American companies are reclaiming lost exports in other ways. Already their know-how is reaping actual rewards in several European countries. In addition, American money is financing an increasing number of petroleum-chemical plants and installations in Europe. On the other hand, as Europe continues to build its petroleum-chemical industry it will become more active in research and thus more technical information can be expected to flow to the United States. An exchange of ideas among European countries is also possible, e.g. France is reportedly interested in acquiring from Italy know-how in the utilization of natural gas.

The United Kingdom

The largest single project in Europe is Imperial Chemical Industries' plan to spend £100 million by 1970 on petroleum-chemical installations on a 1,000-acre site near Avonmouth on the river Severn. Only Wilton, where I.C.I. has spent more than £70 million in establishing an oil-based chemical industry (and plans a further £20 million investment in the near future) approaches the scope of this new development. Last year I.C.I. began operation of its 7,000-ton/year butadiene extraction plant at Wilton. Part of the output will be used in a 10,000-ton/year plant to manufacture Butakon—copolymers of butadiene with a high content of styrene—and some of the butadiene is going to Italy's new synthetic rubber plant. Also at Wilton I.C.I. expects to increase production of Terylene from the present 10,000 tons to 13,500 tons by 1959 and a further expansion of 9,000 tons is planned. The main expansion, mentioned in a previous review, is for polyethylene, which in 1959 will reach 90,000 tons a year, more than 50% higher than the present output. Ethylene oxide capacity will also be increased.

However, the largest increase in ethylene oxide production is scheduled by Petrochemicals, a subsidiary of Shell Chemicals. At Partington, the company is planning the construction of a direct oxidation unit to turn out 25,000 tons of ethylene oxide annually. This production is in addition to 25,000 tons current capacity by the chlorhydrination route, part of which will be turned over to the production of propylene oxide. The new unit will use a process developed by the Shell Development Company, a feature of which is the use of pure oxygen instead of air as oxidizing medium. For the supply of oxygen a "tonnage" oxygen plant is being constructed at Partington. Petrochemicals completed last year its 1,000-ton/year Ziegler polyethylene pilot plant, the first low-pressure polyethylene unit in the U.K. The company is also planning a 15,000-ton monostyrene plant. By the end of the year Shell expects to exchange products through a pipeline link between Partington and Stanlow refinery.

Another ethylene oxide plant using the direct oxidation route is planned by Union Carbide. This will be at Fawley and is scheduled to be producing at the annual rate of 20,000 tons of ethylene oxide and derivatives by 1959 (4).

Fawley is rapidly becoming an important petroleum-chemical centre using raw materials from Esso's refinery. Esso plans to have in operation this year a plant to produce 40,000 tons of butadiene—to feed International Synthetic Rubber's 50,000-ton S.B.R. plant—and in addition large quantities of ethylene and propylene (5). Styrene for the rubber plant will be supplied by Forth Chemicals and Shell. Monsanto's 12,000-ton/year high pressure polyethylene plant, due to be completed next year, will also receive raw material from the Esso refinery, as will Union Carbide when its ethylene oxide plant goes into production. Earlier, Monsanto had planned to build at Fawley the U.K.'s first commercial acrylonitrile plant, but this has since been abandoned. It is rumoured, however, that another U.K. major chemical manufacturer is actively considering such a project.

Another important area for the production of petroleum chemicals is Grangemouth. British Hydrocarbon Chemicals last year began operation of a second cracking plant, thus doubling the output of olefins. Part of the ethylene will be used to make styrene in the recently expanded 30,000-ton/year plant operated by Forth Chemicals, a British Hydrocarbon-Monsanto subsidiary, and some will be used by B.H.C.'s 65,000-ton ethanol plant. Additional amounts will go to two new polyethylene plants: one is British Hydrocarbon's 11,000-ton/year plant using the Phillips low-pressure process; the other, Union Carbide's 11,500-ton/year plant using a modified high-pressure process. British Hydrocarbon is now also separating butadiene from the C_4 fraction from its two crackers to supply feedstock for the new synthetic rubber plants of British Geon, Monsanto and Dunlop. These three plants make specialized rubber and in addition Dunlop runs the pilot S.B.R. plant mentioned in Table 2. Last year British Hydrocarbon completed its 20,000-ton/year propylene tetramer plant which supplies Grange Chemicals with the raw material for the manufacture of dodecyl benzene.

In the field of synthetic detergents, Shell Chemicals's alkylate plant at Shellhaven is producing roughly 28,000 tons of dodecyl benzene, just short of the 30,000-ton/year rated capacity.

Late in 1957 Distillers disclosed plans for a synthetic phenol plant, to be built and operated by British Hydrocarbon at Grangemouth. The plant will use the cumene process, which Distillers developed but which has hitherto been only used overseas, under licence. This will be the first time that Distillers will make use of its own research in this field and the first application of the process in the U.K. The demand for phenol is rising with its increasing use as a raw material for plastics, resins, synthetic fibres, agricultural chemicals, lubricants and other chemical products. In addition to phenol, the cumene process produces acetone. Although the demand for acetone is already being satisfied, the amount arising from the new phenol plant is relatively small and should not seriously aggravate the present market problem.

In the field of inorganic chemicals, an interesting development is I.C.I.'s decision to use oil for the production of synthesis gas for ammonia at Billingham.

France

Expansion of the petroleum-chemical industry in France is progressing at a faster rate than in any other country, though its total output remains behind that of the U.K. and Germany. The most notable developments are centres around Port Jérôme where a variety of plants are now being planned. Presumably the raw materials for these plants will be supplied by Esso's refinery there. Esso plans to spend approximately £5 million on new facilities by 1959.

Among the new units are a 230,000-ton capacity cracking unit ; a 36,000-ton ethylene recovery and purification plant ; an 8,000-ton butadiene recovery and purification plant ; a 26,000-ton dodecyl benzene plant ; and a 20,000-ton/year sulphur recovery plant.

A large part of the ethylene production will become feedstock for the two new polyethylene plants. One, using the Ziegler process, will be operated by Société Normande de Matières Plastiques. The other, using the I.C.I. process, is a 10,000-ton/year unit now being constructed for Société Ethylène Plastique Normandie. The French Air Liquide group of Paris has interests in both the polyethylene producers as well as in Petrochim of Belgium, to which reference is made later.

Esso's butadiene will be piped to Sociètè du Caoutchouc Butyl for a 40/50,000-ton S.B.R. plant being considered for Port Jérôme. In addition to the butadiene from Esso, SOCABU plans to produce butadiene of its own at a neighbouring plant (21). The company's 20,000-ton butyl rubber plant also under construction there is expected to be on stream in October and will provide Europe with its first indigenous butyl rubber.

Last year the first carbon black factory to be built in France came into production at Berre. This plant, which has been built by Cabot France, will eventually produce 25,000 tons of carbon black a year. For the time being the raw material will have to

be imported from the U.S., but by the end of this year it is hoped that supplies will become available from the Shell-St. Gobain (Berre) refinery. Capacity of the plant will ultimately be doubled, thereby satisfying nearly all the needs of the French rubber and printing industries. Last year 45,000 tons of carbon black were imported from the U.S., Britain and Germany.

Société Marles-Kuhlmann will install an ethylene oxide plant at Gonfreville with a capacity of 8,000 tons annually. Compagnie Française de Raffinage will supply the ethylene from its neighbouring refinery. C.F.R. is also planning a tetrapropylene plant at this location. The tetrapropylene will be used to feed the new dodecyl benzene plant planned by Pétrosynthèse S.A., a company formed by Compagnie Française de Raffinage, Atlantique-Progil-Electrochimie and Oronite (Chemical). In addition to the two polyethylene plants mentioned earlier, Manufacturer Normande de Polyéthylène will also construct a polyethylene plant using the Phillips process. This is a combined venture of Rhône-Poulenc, Kuhlmann and C.F.R.

At Lavéra, Naphtachimie has announced future expansion of its output of ethylene by 30,000 tons, and of propylene by 32,000 tons a year. This will bring the firm's annual production of ethylene and propylene to about 50,000 tons each. The additional ethylene will be used to increase Naphtachimie's production of ethylene oxide and its derivatives, and will make available ethylene for the production of Ziegler polyethylene. Butadiene will be extracted from the C_4 stream.

An extremely important development for France is the exploitation of the gas of the Lacq field in the south-west. This gas contains an exceptionally high proportion of hydrogen sulphide. Priority has been given to plans for the recovery of sulphur and it is reported that from a figure of 40,000 tons in 1957 the quantity recovered will rise progressively to 1,250,000 tons in 1962. Other programmes are under consideration for use of the gas in producing chemicals including acetylene, ammonia and raw materials for synthetic rubbers and plastics (6).

Western Germany

After a comparatively slow start due to the emphasis on rehabilitation in the immediate post-war years, the German organic chemical industry is now engaged in a very extensive programme for the development of petroleum chemicals. According to the OEEC, in terms of capital investment nearly $300 million will be spent by the end of 1959 compared with a total of $128 million at the end of 1956. The most ambitious scheme announced during 1957 was the joint venture of Erdoelchemie to be undertaken by B.P. and Bayer. This project, at Dormagen near Cologne, will cost in excess of £20 million and will include ultimately cracking capacity of about 300,000 tons per annum based on feedstock supplied by B.P. The first stage already under construction and expected to be completed at the end of this year is a 60,000-ton Lurgi-Ruhrgas heavy oil thermal cracker scheduled to supply 15,000 tons of ethylene per year as well as other olefinic gases (7). The ethylene will be used for ethylene oxide to be produced in a direct oxidation plant.

A polyethylene plant using the Ziegler low-pressure process is planned by Scholven-Chemie AG., Gelsenkirchen-Buer, with a capacity of 6,000 tons a year. It will go on stream at end 1958.

Esso also plans to enter the petroleum-chemical field in Germany. The company is constructing near Cologne a refinery which will include a steam cracker for the production of olefinic raw materials from light distillate feedstock. The plant is scheduled for completion in 1959.

The Farbwerke Hoechst group, one of the earliest in the petroleum-chemical field, has a very considerable expansion programme. The company has put the total cost of expansion at £34 million and estimates that by the end of 1959 some 300,000 tons of petroleum will be processed annually. Recently Hoechst announced a two-fold increase in production of polyethylene. The company was the first to use the Ziegler process in Germany. Hoechst is also the first in Germany (second in the world) to build a commercial-scale plant for polypropylene. This plant has a capacity of 7,500 tons per annum and was commissioned last December. A substantial increase is also planned for the Trevira (I.C.I.'s Terylene) synthetic fibre plant.

Anorgana, a wholly owned Hoechst subsidiary, will install an oil cracker at Gendorf to supply olefinic raw materials. This will supplement the current supply of ethylene and other gases produced via acetylene from carbide manufacture. This is part of a project for increased output of ethylene oxide and derivatives.

Expansion of ethylene oxide capacity, now about 40,000 tons annually, is playing an important part in West Germany's plans for increased production of petroleum chemicals. In addition to those already mentioned Chemische Werke Hüls have recently commissioned a new ethylene oxide plant employing their own oxidation process. Chemische Fabrik Holten, a subsidiary of B.A.S.F., has also expanded its ethylene oxide capacity using the Scientific Design process and currently produces about 10,000 tons a year. The company plans a further and considerable increase in capacity within a few years.

A large part of Germany's organic chemical industry is based upon acetylene derived from calcium carbide, in turn produced electro-thermically from coke and lime. In recent years coal and electricity prices have increased. Looking to the future several West German chemical producers who rely upon cheap and continuous acetylene supplies have been seeking alternative sources for their acetylene. Natural gas supplies in Western Germany, although larger than in most European countries, do not supply the answer to future acetylene availability and consequently petroleum, which is relatively stable in price, has received considerable attention as a source for acetylene. Particularly active is Hoechst who has developed a process for high-temperature conversion of light petroleum fractions (currently in long supply in Europe) into acetylene and ethylene by pyrolysis in a methane-oxygen flame at 1,200° C. Ethane and propane, by-products of this process, may be converted by intermediate (1,200° C.) pyrolysis to yield additional ethylene and propylene.

Italy

Although Italy's petroleum-chemical industry is smaller than that of Britain, Germany or France, the country is very active in research and development work, notably with natural gas and polymers. A major achievement in 1957 was the first commercial production of polypropylene, claimed as having a future comparable to polyethylene. The thermoplastic, Moplen, is being commercially produced by Montecatini at Ferrara. Moplen has a variety of potention applications, but it appears that initially it will be used in moulded products ; opaque to translucent household products, squeeze bottle, pipes and fittings, pump parts, automotive parts and the like. The material has a high resistance to heat (over 300° F.), which permits sterilization of moulded products, and shows high impact strength. It is said to have excellent resistance to grease and oil and to many common acids. Montecatini has further important plans for polypropylene. Research done in close connection with Natta's group at the Politecnico of Milan has shown that a polypropylene modification with elastomeric properties can be made. Of great interest are polypropylene fibres, which have been woven into socks and other garments and, although the dyeing of polypropylene has been a problem, some progress has been made in adapting conventional techniques. Natta has given an excellent account of his work in his lecture to the Society of Chemical Industry in London in February, 1957 (8). Montecatini also announced last year a three-fold increase in capacity of its recent petroleum cracking unit to 80,000 tons annually of ethylene and propylene together with additional quantities of C_4s (9). The propylene will presumably be used by the Moplen plant and to utilize fully the C_3s and C_4s the company will also expand its plants for the manufacture of polymers, oxides, aldehydes, acids and alcohols.

A major part of Italy's petroleum-chemical industry is based on natural gas. In 1954 consumption of natural gas for chemical synthesis was 207 million cubic metres. This rose by 60% to 329 million cubic metres in 1956 and is expected to climb steeply in the future (10).

Natural gas from the Po Valley will be used as a raw material for the S.B.R. and fertilizer plants under construction at Ravenna by ANIC. Since the plans were first announced (11), capacity of the fertilizer plant has been increased to 650,000 tons a year. The unit is expected to be in operation within a few months.

The first company to use methane for fertilizer production in Italy was Montecatini. In 1949 the company started development of its process for partial combustion of natural gas with air to produce synthesis gas for nitrogenous fertilizers. This process now in use by Montecatini at Ferrara and Novara, together with the proposed ANIC plant, will be responsible for well over a million tons of nitrogenous fertilizers a year.

The ANIC synthetic rubber plant, which will manufacture under licence from Phillips Petroleum (12), will initially produce 35,000 tons a year and later 55,000 tons. Earlier reports state that ANIC is building a plant to produce butadiene from natural gas via a rather long route with acetylene as intermediate. In addition to this source it was later announced that butadiene will be made in a Houdry dehydrogenation plant, presumably from butanes, at the rate of 18,000 tons a year. At present some butadiene is coming from I.C.I. and Goodrich Gulf Chemicals is also shipping the material to Ravenna from Port Neches, Texas. To begin with ANIC will purchase the styrene required for the S.B.R. but by the end of this year hopes to be receiving styrene from a 14,000-ton Koppers plant this company is building at Ravenna. At present monostyrene is made in Italy only by Montecatini at Ferrara.

In addition to Montecatini's production of polyethylene, the product is receiving attention from other companies. Celene SpA, a new company owned jointly by Union Carbide and Italian Edison, plans a 10,000-ton/year plant in Sicily. Also in Sicily, A.B.C.D., who was at first reported to be constructing a 5,000-ton/year polyethylene plant at Ragusa, has since revised this to 10,000 tons. The ethylene would come from a petroleum cracking installation also projected by A.B.C.D. Solvay et Cie. of Brussels is reported to be planning a polyethylene plant using the Phillips process, for which they have the Italian licence.

Other European Countries

Outside the main refining countries there are a number of interesting proposals in other European countries.

In the Netherlands the Royal Dutch/Shell group is planning to build a 50,000-ton synthetic rubber plant next to its refinery at Pernis. A second synthetic rubber plant was announced for Holland early this year. Algemene Kunstzijde Unie (A.K.U.) and Goodrich Chemical plan to form a joint company for the manufacture of special purpose synthetic rubber. The new plant will be at Arnhem and will be the first on the Continent using Goodrich know-how.

Furthermore, a 5,000-ton polyethylene plant, using the Ziegler process is to be built by Staatsmijnen of Limburg. According to the latest reports the company, which has been running a pilot plant using this process, will adopt the I.C.I. high-pressure process for a 7,000-ton/year plant. It is expected that commercial-scale production will start at the end of 1958.

In Belgium the first unit of a petroleum-chemical complex at Antwerp operated by Société Chimique des Dérivés du Pétrole (Petrochim) went on stream last year. This plant will make synthetic detergents.

In co-operation with M. W. Kellogg, the Société Belge de l'Azote (S.B.A.) has developed a process for the manufacture of acetylene and ethylene simultaneously using either light liquid petroleum feedstocks or natural gas as raw material. Using naphtha feedstock, the ratio of acetylene to ethylene can be varied over a wide range.

A petroleum-chemical industry in Austria is likely to be hinged around the Austrian Mineral Oil Administration refinery at Schwechat near Vienna, and due to come on stream within the next three or four years. Two schemes appear to have been under negotiation over the last few months : one, a £2 million low-pressure polyethylene plant to be operated by the German Farbwerke Hoechst and unidentified Austrian partners ; the other, a £2.75 million plant reportedly for the manufacture of ethylene oxide, polyethylene and polypropylene, to be a joint operation of Stickstoffwerke Linz and Montecatini.

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Book Review

The Properties and Testing of Plastics Materials

By A. E. Lever and J. Rhys. 197 *pp.*

Published by Temple Press Ltd. Price 30*s.*

The authors state that this publication is intended as a " source-book," a reference work for those engaged in the testing of plastics. It is, in fact, more than this, because it provides matter of interest to all those concerned with the use and application of plastics. It covers a wide range of industrial materials, the only important omission apparently being epoxy resins (and even these receive brief mention in two places). Testing procedures are given for mechanical properties, including creep, hardness, abrasion and fatigue; physical properties including viscosity, damping, adhesion and ageing ; thermal, optical and electrical characteristics and finally chemical properties including analysis. For good measure, there are sections devoted to actual properties of specified materials, testing of finished mouldings and efficiency of plasticizers, together with a summary of the principle standards organizations of the world. There are no less than 1,526 references to the literature which means that an exceptionally wide bibliography is provided; its utility is assured by appropriate pin-pointing of the subject in the text. These facts provide in themselves ample evidence of how useful the book can be to those engaged in the technology of plastics. It could be made even more useful in a second edition by attention to certain points.

First of all, being a source book and thus resembling a dictionary, it does not make " easy " reading. It is understandable that in any reference work this should be the case, but constant reiteration of the same phrases can be irritating. Secondly, in a " source book " it would be a great advantage to provide authors' names, even if it is considered an unnecessary luxury to give the titles of papers. In this connection, however, accuracy is of importance and it is unfortunate that in some places where names are given, e.g. refs. 104 and 105 on p. 118, mis-spellings have crept in. Thirdly, the text is much too uncritical and provides little guidance on the merits of different methods. Sometimes, also, poor definitions are given, e.g. shear strength, p. 20 and damping capacity, p. 64, although perhaps these are of secondary importance. Fourthly, some of the diagrams and tables need editing; for example on pp. 9/10 there is confusion over the symbols for stress and strain, on p. 53 it is not immediately clear that 10×10^6 refers to the number of cycles and not to tons/sq. in., on p. 65 the mysterious symbol in col. 4 of the table should be the Greek σ while on p. 76 the linear shrinkages given in the table are useless unless dimensions of specimens are included. On a technical point, it is quite incorrect on p. 97 to describe polyesters, whether filled or unfilled, as opaque and as having limited colour possibilities.

Despite these criticisms, the book is of much value. A second edition, incorporating the obvious improvements which they suggest, could be a standard work of reference to the plastics industry. It should be bought by all those engaged in testing, using or making plastics.

N. J. L. MEGSON.

Plastics in Stencil Manufacture

Printing with stencils is an important part of commercial life. In this note, compiled by Gestetner Ltd., the contribution of plastics to the manufacture of stencils for use all over the world is described.

EVERY typist knows what a stencil is: but not every chemist knows what it is made of. A stencil is a pressure-sensitive coating supported on a porous tissue so designed that the impact of the typewriter character clears away the coating, called the melt, leaving a mechanical image, through which ink is subsequently passed.

Composition

A stencil is essentially a product of the plastics world. The material most generally employed in present-day stencil-making is nitrocellulose. It is highly plasticized with extenders such as oleic acid, oleyl alcohol, castor oil and mineral oil, none of which would be classified as true plasticizers by the lacquer or paint maker. It is probable that the extender forms a discontinuous phase embedded in a continuous fibrous matrix or honeycomb of the nitrocellulose, and that the pressure-sensitive nature of the product depends on this structure. A secret of successful stencil-making resides in preventing the melt from bonding together too tightly the fibres of the supporting tissue. If the fibres are cemented together in this way they cannot flex or move under the blow of the typewriter, but fracture instead, causing cut-out of loop letters like e and o. The centre of a loop letter such as o is held by a bridge of fibres. If too many fibres are fractured the bridge collapses and cut-out results.

The stencil is usually supported on a backing sheet and typed on a "carbon," which is inserted, waxy side up, between stencil and backing. A "carbon" consists of a wax containing carbon black spread on a suitable tissue. It has a controlling influence on the quality of copy and in preventing cut-out.

The waxy coating can be applied to the backing so that the conventional carbon can be dispensed with. Such coatings have consisted of plastics compositions, of which the following is an example:

Polyvinyl chloride	..	1
Tri-tolyl phosphate	..	2
White lead	.. ..	0.006

applied as a plastisol and stoved at normal gelling temperatures.

Stencils do not keep for ever: they are essentially perishable products in so far as their plasticizers may consist of fatty acid compounds. A great deal of research has been done on the use of anti-oxidants to prevent or delay these chemical changes. Similar work has been done in the margarine industry. An interesting discovery has been that traces of metals (iron and copper) greatly accelerate the oxidation of these compounds. In severe cases the stencil may become rancid or even sticky in hot countries.

These metals can be inactivated or sequestered by use of such recognised sequestering agents as potassium fluoride or ethylene diamine tetra acetic acid. In the presence of these sequestering agents the traces of copper and iron are unable to effect their accelerating action on the course of oxidation largely because they are converted to negative non-oxidizing ions. The stencil is in this way accorded a much longer shelf life.

Stencils originally were made of gelatin. This so-called protein stencil had to be wetted with water before being placed in the typewriter. By this means the gelatin was softened and swollen and made pressure sensitive. Excellent copy was possible from such stencils: but everybody disliked the trouble of preparing them for the typewriter. They were liable to dry up in hot weather and were sometimes not so easily wetted out and conditioned.

The nitrocellulose stencil became known as the durable stencil, and nitrocellulose has been the standard stencil-making material since the 1920's. Many other plastics have been examined experimentally for their stencil-making properties, either alone or in conjunction with nitrocellulose or other polymer. Thus stencils have been made from cellulose acetate and also from cellulose-acetate-butyrate, the mixed ester. An even more useful mixed ester is cellulose-acetate-oleate. These mixed esters have been employed to make stencil coatings from hot melts without the use of solvents. Traditionally nitrocellulose stencil melts are coated from conventional solvent mixtures as used in the lacquer trade. Hot melt spreading becomes possible by application of cellulose-acetate-butyrate and other mixed esters. A hot melt formula of this nature would be as follows:

1 part of ½ sec. cellulose-acetate-butyrate.
4 parts of oleic acid.
Heated until clear: apply as hot melt.

Polystyrene and polyvinyl acetate are also employed in stencil-making, but in combination with nitrocellulose, and as additional rather than as main melt coatings. Plastics in stencil-making are ever being studied in an endeavour to find substitutes for nitrocellulose or additives to improve it.

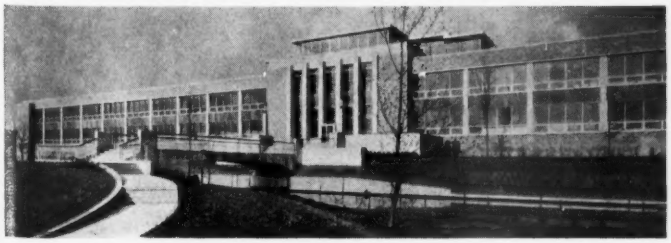
New Factory for Cincinatti

ONE of the most modern factories in the world was recently completed on the outskirts of Birmingham, the new plant of Cincinatti Milling Machines Ltd. At this factory are made the British built Cincinatti machine tools, including the products of constituent companies, Hordern Mason and Edwards Ltd. and Heald Machines Ltd. Many of the machines constructed by the company are employed by the plastics industry in the manufacture of moulding equipment and tools and dies.

The administrative building incorporates many novel features not least of which is the extensive use of p.v.c. for flooring, wall coverings and upholstery. Decorative laminates have been used for the table tops in the two large canteens and Mylar has been employed for the diffused lighting panels in the ceilings.

Facing on to Castle Bromwich airport, the factory is approached by an attractive reinforced concrete bridge spanning the canal which runs along one side of the site. The bank of the canal has been laid out as a garden.

Maintenance costs have been reduced to the minimum throughout the factory and administrative buildings by the use of light alloy window frames, stainless steel and ceramic tiling applied to all the walls. The photographs on this page will give some indication of the progressive ideas employed by the architects planning this new plant.



(Left) New office block.

(Right) View of production line.

Plastics in the Laboratory—Part 2

By G. HAIM*

Continuing the series commenced last month, the author discusses in this instalment funnels, graduates, instrument covers, jars, jet pumps, laboratory coats, fittings, ladles, manometers, neutralizing boxes, peg-boards, pipettes, and other items.

Funnels

The majority of polythene funnels are moulded. For ease of filtering they should be truly circular. Polythene funnels are superior to glass funnels in that they can be made with an angle of 60°; glass funnels frequently do not conform to this requirement. Polythene funnels should be fluted on the outside, to allow the escape of air when filtering—flutes on the inside are less desirable.

All polythene funnels have a short stem, as it is difficult to mould a long stem. Where necessary, an extension piece can be welded on. A distinction should be made between cheap, flimsy polythene funnels and the expensive type with a heavy wall, which give much more satisfactory results. The flimsy types are really not suitable for filtration purposes, as the filter paper should closely follow the shape of the funnel, which it cannot do in the case of a distorted or oval funnel. Moulded polythene funnels are obtainable in various sizes, with diameters ranging from 1 in. to 12 ins.

Acrylic funnels have a somewhat limited use on account of the material from which they are fabricated, but they are quite suitable for weak acids and alkalies and for photographic purposes.

The composite acrylic funnel shown in Fig. 10 is a particularly useful device. It

Fig. 10. Composite acrylic funnel.

consists of two acrylic funnels connected by a stainless steel rod and disc. The larger funnel fits inside the smaller funnel. Under normal circumstances (when freely suspended), the outer funnel moves away from the inner one due to the weight of the inserted stainless steel disc and rod, which closes the inner funnel completely. When the device is inserted into a flask, the outer funnel moves up, and the powders or liquids contained in the inner funnel can flow freely into the receptacle. As soon as the device is removed from the support, the gap is closed, and the transfer of liquid or powder ceases.

Funnel Aids

Difficulties are sometimes encountered when a funnel is inserted into a flask, especially when the contour of the cone of the funnel follows closely that of the rim of the flask and thus closes the aperture hermetically. A moulded polythene disc with supporting feet (funnel aid) (Fig. 11) is placed on top of the flask to facilitate

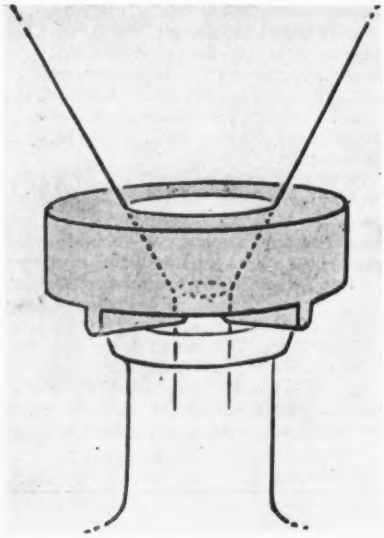


Fig. 11. Polythene funnel aid.

the escape of air. This device can be used with funnels varying in size from 3 ins. to 6 ins. diameter.

Funnel Stands

For multiple filtering operations steel or wooden funnel stands are often used in laboratories dealing with routine work. The wooden stands distort when soaked by liquids, whilst steel stands—even when painted or enamelled—corrode in due course.

A new stream-lined funnel stand made from acrylic material and accommodating six funnels is shown in Fig. 12.

Graduates

The majority of plastic graduates are moulded in polythene (Fig. 13). Their capacity varies

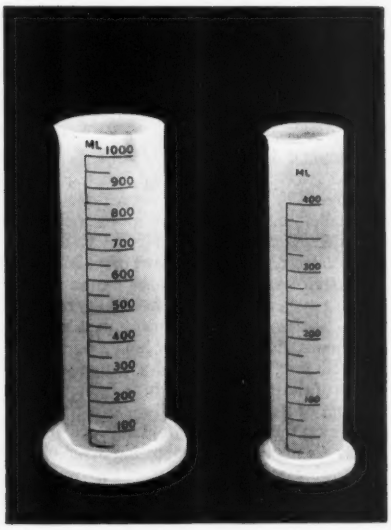


Fig. 13. Polythene graduates.

from 5 ml. to 1,000 ml. Large graduates, up to 5,000 ml. capacity, can be made up by welding. The accuracy of polythene measures is somewhat limited, as the shrinkage of moulded polythene articles cannot easily be controlled. Slight differences in moulding or cooling temperatures cause a different degree of shrinkage or expansion, and it is, therefore, practically impossible to produce polythene graduates with the same degree of accuracy as glass measures, which are individually graduated. The calibration of polythene graduates is effected either by engraving the mould (with the numerals protruding from the outer surface) or by hot stamping or silk-screen printing after moulding. In both cases organic dyes are used, which will dissolve when in contact with organic liquids or concentrated acids, and from this point of view graduates with moulded-in numerals are preferable.

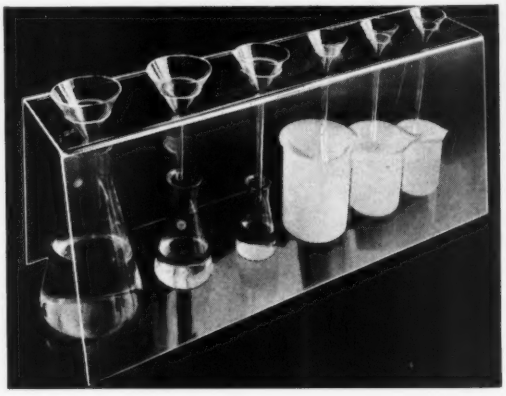


Fig. 12. Acrylic funnel stand.

* Rediweld Ltd.

American graduates made in America suffer from the same degree of inaccuracy. It is very often claimed that calibration has been carried out at 20° C., but check tests will soon prove that the claim is exaggerated.

The reading of the meniscus on polythene graduates is much more difficult than with glass. On the other hand, polythene measures are not breakable, and they can be used with hydrofluoric acid, where glass is out of the question.

Acrylic graduates are perfectly transparent and individually graduated in the same way as glass. There is, of course, no Government certificate available for this type of measure. Acrylic measures have a certain application in the foodstuff industry, where glass measures are dangerous; accidentally dropped, they may leave glass splinters in the foodstuff treated, and heavy penalties may be incurred as a result. Acrylics crack and break into several large pieces, which are easy to recover, but definitely do not disintegrate into very small splinters or powders.

Whenever acrylic measures are used for essential and aromatic oils and flavours, it must be remembered that these liquids will partly penetrate into the acrylic material and be absorbed. Care should, therefore, be taken to prevent the mixing of different flavours or perfumes and a separate measure be used for each of the aromatic or essential oils.

Acrylic graduates (Fig. 14) are obtainable in sizes up to 3,000 ml. capacity. Shock-resistant toughened polystyrene graduates are ideal for applications in the food industry, but unfortunately they are available only in one or two sizes.

Fig. 14. Acrylic graduates.

Instrument Covers

Microscopes, colorimeters and other standard instruments are usually kept under dust-proof glass covers. These are, however, rather expensive and fragile. Acrylic instrument covers have replaced glass covers to a fair extent. Another way to protect valuable laboratory instruments is by covering them with wrappers made from flexible transparent p.v.c. by stitching. Zip fasteners can be incorporated to make these covers practically airtight.

Jars

A wide range of polythene jars up to 5-gallon capacity (Fig. 15) is now available. Acrylic and p.v.c. jars are also in use, but they are more expensive than polythene jars.

Fig. 15. Polythene jars.

Jet Pumps

The customary laboratory jet pump is made of brass and chromium plated or blown from glass. The glass pumps break easily and are, therefore, not too popular, whilst the metal ones corrode in time. Standard jet pumps moulded in a phenol formaldehyde compound (Bakelite) (Fig. 16) are now available at an economic price. For special applications p.v.c. jet pumps can be supplied, but due to the small numbers produced they are a somewhat expensive proposition.

Fig. 16. Jet pump mouded in phenolic material.

Laboratory Coats and Protective Clothing

All chemists find that cotton laboratory coats do not last long. Acids soon burn holes in the material, and frequently the damage is noticed only after washing. Attempts to improve the useful life of cotton coats by impregnation have not been found sufficiently successful to warrant the higher cost.

P.v.c., Terylene, Orlon and nylon laboratory coats are now becoming increasingly popular. P.v.c. will give considerably longer and better service than all other garments made from artificial fibres, but the appearance of nylon or Terylene coats is much more stylish.

It should be borne in mind that shrinkage or damage will definitely result from drying laboratory garments made of synthetic materials on heated radiators or from leaning against radiators.

Laboratory Fittings

Standard laboratory fittings for gas and water are made of gun-metal with a black or brown finish. Sometimes they are chromium plated. They become severely corroded in time and have to be replated, repainted or replaced. Nylon and p.v.c. moulded fittings of the same pattern are now available, but it is too early to say to what extent they will take the place of metal fittings. They are satisfactory as far as corrosion resistance is concerned, as they are not attacked by fumes, but they still have certain disadvantages: e.g. p.v.c. fittings are somewhat brittle and may break when metal spanners are used; nylon fittings (obtainable in a variety of colours) are only surface-dyed, and the colour wears off in time, leaving them mottled in appearance. There is no reason why the nylon could not be dyed throughout, which will probably come with mass production.

Ladles

Plastic ladles (Fig. 17) fabricated from p.v.c. or polythene are useful for a wide range of corrosive liquids and powders and are definitely to be preferred to enamelled ladles, which chip very easily.

Fig. 17. P.v.c. ladle.

Manometers

Glass manometers break easily and cause considerable annoyance if broken, especially if they are filled with mercury. The nuisance of replacing the broken instrument is of minor importance compared with the trouble of collecting the mercury that has been spilt all over the place. Plastic manometers manufactured from transparent flexible p.v.c. twin tubing with a stainless steel movable scale are virtually unbreakable. They have the further advantage that they can be rolled up and carried in the pocket or a small container, to be unrolled on site. They are made up to

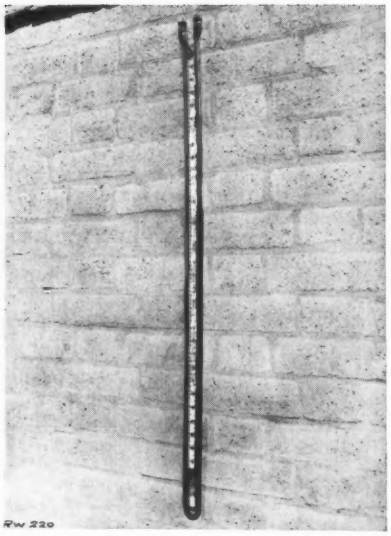


Fig. 18. Plastic manometer in position.

customers' requirements, with readings varying from 8 in. to 120 in.

Fig. 18 shows a plastic manometer in position. Fig. 19 shows the same manometer rolled up after use.

Mounting of Specimens in Plastics

In the good old days metallurgists mounted their specimens in plasticine or putty. Since the late '30s the mounting of metallurgical specimens in a phenolic or acrylic compound has become standard practice, and special presses have been designed for this purpose. Great care should be taken when mounting the specimen, as slight crevices and fractures will retain staining and etching liquids, with the result that the specimen, instead of being protected by the surrounding plastic, will sooner or later perish under the continuous action of the residual liquids.

Biological specimens, small animals, flowers and plants can be embedded in monomeric methyl methacrylate, which is then polymerised thus preserving the specimens perfectly in their original colour and shape.

Neutralizing Boxes

The disposal of corrosive waste liquors resulting from operations in chemical laboratories into town sewers is forbidden, and precautions have to be taken for their neutralization.

The most useful and satisfactory devices available for this purpose are wooden boxes with built-in weirs. An improvement consists in lining the boxes with polythene. The neutralizing boxes are afterwards filled with hydrated lime to neutralize the acid. It may be necessary to add further chemicals to dispose of poisons.

Non-return Valves

There are numerous applications for non-return valves in a chemical laboratory. A typical application is the use of a non-return valve between suction flask and jet pump for filtering precipitates on a Buchner funnel. When the jet pump is turned off, the vacuum in the filter flask causes the water from the jet pump to siphon back into the vacuum flask, which is rather troublesome in cases where the filtrate is to be used afterwards. Moulded polythene non-return valves can be used with advantage in such cases.

Fig. 19. Manometer rolled up after use.

Peg-boards

Wooden peg-boards are employed for the drying of chemical glassware. What has been said about wooden draining boards applies also to wooden peg-boards, i.e. they warp and split.

P.v.c.-covered wooden boards with p.v.c. pegs are a great improvement. They are considerably more expensive than wooden ones, but they last longer and are more attractive. Fig. 20 illustrates a p.v.c. covered peg-board in a laboratory.

Petri Dishes

Petri dishes made of glass are a standard item in all biological laboratories. They break easily and have frequently to be replaced. Polythene petri dishes can be used in cases where transparency is not required; an alternative is a dish made of cellulose acetate. The latter can be used only once, as it cannot be sterilized by steam. Cellulose acetate dishes are, however, so cheap that they are still competitive with glass, although they must always be discarded after use.

Pipettes

Many chemists appear to wish to use plastic pipettes, assuming that they will not fracture as easily as glass. So far, plastic pipettes have not proved satisfactory.

Some years ago an American firm marketed polystyrene pipettes for the handling of hydrofluoric acid, but they were apparently not as practical a proposition as one would think, and they seem to have disappeared.

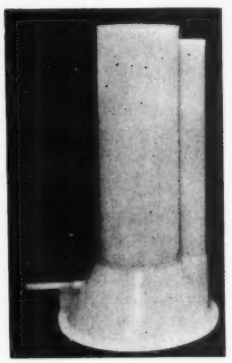
Thermoplastic materials cannot easily be blown or calibrated, which is the reason why plastic pipettes are not a practical proposition. The demand for plastic burettes can likewise not be met.

Pipette Washers

Pipettes are a constant source of trouble in laboratories; although most laboratories keep a large stock, it will be found that a high proportion are more or less useless due to chipping of the tips. The handling (washing) of pipettes is considerably facilitated by the use of plastic pipette jars. A further improvement is the use of a plastic pipette washer.

The pipette washer shown in Fig. 21a and 21b is fabricated from polythene and carries an inverted automatic siphon. The complete outfit consists of a washing container filled with chrome sulphuric acid, which, in the low concentration used, does not attack polythene. The pipettes are placed inside a polythene carrier, designed in such a way that the tips of the pipettes cannot be chipped off or broken. This carrier, with the pipettes inside, is withdrawn from the washing container after adequate immersion in the acid and transferred to the actual pipette washer. The filling of the pipette washer with water takes approximately three minutes and the siphoning-off period is approximately one minute. The pipettes can be withdrawn after a relatively short time and left to air dry in the usual way.

(*To be continued*)



These two photographs (Fig. 21a and 21b) illustrate a pipette washer fabricated in polythene with an inverted automatic syphon.

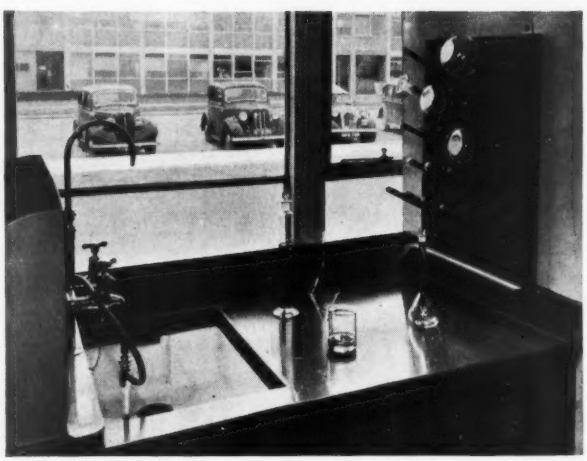


Fig. 20. This photograph illustrates the use of a p.v.c. peg-board in a modern laboratory.

Patent Review

The following abstracts have been made from specifications at the Patent Office, with the permission of the controller of H.M. Stationery Office. The country of origin for Convention Applications is shown in parentheses. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 3s. 6d. each (including postage).

B.P. 786,263. Display device. Compra Plastics Ltd., R. H. Sturm.

A base of, e.g. polystyrene or polyvinyl chloride, vinyl copolymers, acrylic polymers or copolymers or impregnated porous material is provided with a highly reflecting coating in liquid form. On top of this a phosphorescent and/or fluorescent compound is applied which, before drying, is closely covered with very fine spherical glass particles. For road signs, etc.

B.P. 786,264. Surface covering sheet. To: Bonafide Mills Inc.

Refers to a binder made of a cementitious gel (tall oil and epoxy resin) mixed with vinyl resin.

B.P. 786,282. Closure means for liquid containers, primarily bottles. A. Hodson. To: Containers & Closures Ltd.

A sealing ring of plastic (" Alkathene ") is so shaped that an open space of upwardly increasing cross-section is left when the ring is in position. This ensures such a deformation when under the pressure of a screw cap or screw plug that even malformed bottle mouths are tightly sealed.

B.P. 786,355. Manufacture of artificial sausage casings. B. V. Fox, G. D. Pearce, R. G. Hardiman. To: British Cellophane Ltd.

Alginate sausage casings with controlled transverse stretch resulting in more rapid and more uniform filling, easy linking, more pleasing appearance are made by subjecting the casing to a drying treatment followed by rehumidifying until saturated with water. The casing is then inflated by fluid pressure.

B.P. 786,372. Filler cap device for maintaining the level of the electrolyte in electric accumulators. W. E. O'Shei.

A resiliently compressible container (" Alkathene ") with apertures in a tubular extension at the correct level of the electrolyte and with vent openings for the escape of gas.

B.P. 786,377. Panels. To: Benjamin Electric Ltd. (U.S.A.).

Sound absorbing material is carried in deformations of a rigid sheet of light transmitting material. (" Vinylite.")

B.P. 786,381. Polymeric materials. To: Soc. d'Electro-Chimie, d'Electro-Metallurgie et des Acieries Electriques d'Ugine (France).

Macro-molecular compounds which, being initially soluble and fusible, are transformed into three-dimensional insoluble and esentially infusible products.

B.P. 786,390. Buttons. G. Wilkes.

One central large hole and smaller holes around it

B.P. 786,416. Vacuum deep-drawing of thermoplastic sheet material. To: Hydro-Chemie A.G. (Switzerland).

A maximum vacuum is applied to the mould when the material is about to make contact with the surface of the perforated mould and this vacuum is maintained or even increased till the material has solidified. (Add. to 781,979.)

B.P. 786,428. Moulding devices for use in the flour confectionary and baking trades. F. White.

A hand appliance (template) of Perspex.

B.P. 786,503. Covers for lamps. C. W. Heath. To: Carr Fasteners Co., Ltd.

For coloured warning lights on dashboards of motor vehicles, with a concave-convex lens portion integral with a tubular shank portion formed, e.g., of nylon.

B.P. 786,526. Cleaning brush, particularly for mouth treatment. C. L. Longert (Switzerland).

The brush is equipped with an elastic bag in the handle for squeezing liquid through ducts and passages to the bristles.

B.P. 786,764. Production of moisture-proof sheet wrapping materials having a normally solid polyethylene plastic coating. R. A. Rose, C. R. Poma. To: British Cellophane Ltd.

It has been found that the polyalkylene amines are especially advantageous for anchoring moistureproofing surface coatings of normally solid polyethylene plastics to regenerated cellulose base films.

B.P. 786,783. Modified polyamide resins. G. Swann, P. G. Evans. To: Beck, Koller & Co. (England), Ltd.

Reaction product of formaldehyde, a dimeric fatty acid, and an aliphatic triamine. The resins have film-forming properties in solution in volatile solvents.

B.P. 786,790. Reservoir tooth brush. To: Dental Clean Establishment. (France).

B.P. 786,801. Clothes peg. F. J. King.

Of spiral shape.

B.P. 786,901. Apparatus for transverse stretching of thermoplastic films. To: Kalle & Co. A.G. (Germany).

The thermoplastic film is stretched between a pair of endless chains provided with clamps gripping the opposite lateral edges of the film. While the film proceeds longitudinally the chains diverge.

B.P. 786,915. Method of manufacturing hollow articles partially composed of resin impregnated yarn windings. To: Specialities Development Corp. (U.S.A.).

High pressure resistant receptacles are made from strands of yarn individually impregnated with a liquid resin and then applied in groups as a winding to a hollow member. The strands are kept uniformly tensioned, finally heat cured retaining the hollow member as a liner.

B.P. 786,920. Method of automatically forming cast or moulded products with inserts therein. To: J. & P. Coats Ltd. (U.S.A.).

Travellers for ring spinning and twisting frames in the form of plastic yokes with hook-shaped ends the larger one of which has a reinforcing metallic insert.

B.P. 786,967. Screw-stoppers for bottles and other containers. T. S. Kirkby. To: Precision Products (Leeds) Ltd.

A hollow stopper in which the plug joins the head through a hollow integral sealing ring in the form of a truncated cone.

B.P. 786,980. Envelopes for gramophone records. H. D. Christmas. To: Electric & Musical Industries Ltd.

Made of polythene. The envelope is provided with outwardly projecting ears.

B.P. 786,991. Artificial flower. A. E. Decamp (France).

A plurality of petal-sets each of which is carried by a mounting element formed with an aperture so that the elements can be threaded together. They are injection moulded.

B.P. 787,022. Self-hardening, liquid resinous compositions and articles having the resinous composition bonded thereto. To: Minnesota Mining & Mfg. Co. (U.S.A.).

A protective coating, heat- and solvent-resistant impregnant, etc., comprising a (semi) liquid epoxide resin and a liquid aliphatic saturated polythio-polymercaptan.

B.P. 787,090. Ampoules. British Xylonite Co., Ltd. H. Senior, P. A. Trotter.

With a hollow tubular body of a flexible thermoplastic. It has a neck at one end with an annular shoulder of less mechanical strength so that it can be pressed into the body with a progressive infolding of the side wall.

B.P. 787,093. Pocket-size toothbrush appliances. F. Engel. To: Daily Use Ltd.

A cylindrical container with a screw cap to which are fixed a single tuft brush and a tooth pick.

B.P. 787,106. Brushes. L. R. Bressler.

Flexing movement of parallel bristle sections is obtained by transversely extending thin spring-like members of plastic material (nylon) connecting the sections.

B.P. 787,203. Means for attaching constructional surface parts of non-metallic synthetic sheet material. To: Daimler-Benz A.G. (Germany).

A connecting sheet metal strip of L-shaped cross section is used. One limb is anchored in the surface part, the other projecting limb has incisions extending transversely from its outer edge to enable the strip to bend. For motor vehicle construction.

B.P. 787,210. Joining synthetic foils and the like, particularly for packing foodstuffs and delicacies. W. Wendt (Germany.)

One or both surfaces to be joined are coated with an agent of an ester of a polyhydric alcohol and of a low aliphatic monobasic carboxylic acid. The coating agent acts as a plasticizer for the foils employed which are after the coating step, pressed together.

B.P. 787,228. Weather shield for use with motor vehicles. H. H. Bate. To: W. P. Walcott.

A detachable shield of transparent plastic material permitting hand signals despite complete protection against weather.

B.P. 787,260. Method of manufacturing structures from thermosetting plastic materials combined with fibrous materials. T. F. Crang, E. R. Cooper, R. E. Smith. To: J. Samuel White & Co., Ltd.

At least one of the surfaces of one part of the structure formed from thermo-setting plastic and fibrous (glass fibre) material has incorporated fibres which project partly from this surface. The projecting ends are embedded in another thermo-setting layer applied to this surface and cured afterwards.

B.P. 787,277. Rollable laminated sheet material and method for the manufacture thereof. To: Hawley Products Ltd. (U.S.A.).

The upper side is a hard polyvinyl chloride (polyvinylidene or other thermoplastic sheet material) with a hard surface resistant to staining, soap and water. A porous sheet is fused to the underside. Spaced transverse (wooden) strips are bonded, e.g., by a polyvinyl acetate or a urea-formaldehyde adhesive to the porous surface on the underside so as to enable

the laminated sheet to be rolled up and used, e.g., for extensible table tops (picnic tables, etc.).

B.P. 787,287. Apparatus for playing a game. N. V. Walson.

A (plastic) playing area with (plastic) blocks of coloured letters for each player.

B.P. 787,326. Denture material, denture and method of producing. To: Luxené, Inc. (U.S.A.).

A pair of joined laminated sheets of translucent flesh tinted plastic material (vinyl copolymers, polymethyl methacrylate) with randomly disposed fibres in between coloured to simulate veins.

B.P. 787,403. Treatment of films of polyethylene resins. To: Celanese Corp. of America (U.S.A.).

The receptivity towards printing inks is improved by subjecting the film surface to a corona electric discharge between a rotatable cylindrical electrode round which the film travels and a part-cylindrical electrode concentric with the first electrode.

B.P. 787,414. Garment fitting and pattern making aid. E. M. Franklin.

Use of inter-engaging and adjustable (plastic) strips to fit the various body portions.

B.P. 787,468. Manufacture of reinforced moulded articles. H. N. Ewer. To: G. S. E. Equipment and Contracts Ltd.

The reinforcing metal member is held in the mould by supports, e.g., of polythene with contact points to locate them. The molten polythene then flows past the supports which soften and become welded to the article.

B.P. 787,473. Manufacture of pressure-sensitive adhesive tape. G. B. May. To: P. P. Payne & Sons, Ltd.

The adhesive solution is coated on to a weftless base of parallel strands of synthetic filaments or fibres bonded side-by-side.

B.P. 787,475. Adherent synthetic resin coatings on pergamyn and parchment papers. H. Newby. Comm. from: Chemische Werke Hüls A.G.

Synthetic resin dispersion containing at least five parts of shellac to 100 parts of resin. For making moisture-proof packing paper.

B.P. 787,587. Dish-washing mop or brush. D. S. Instance.

A head of moulded flexible material having bristles pivoted to a handle.

B.P. 787,592. Sheet structures, polymeric materials for use in the production thereof, and a process for producing said sheet structures. To: Farbenfabriken Bayer A.G. (Germany).

Two-dimensional bodies (foils, coating) by reaction of a soluble branched isocyanate-modified polyhydroxy compound with a polyisocyanate.

B.P. 787,681. Means for securing a knob to a shaft. E. K. Cole Ltd., W. J. C. Jackson.

A moulded plastic knob with a centering device.

B.P. 787,682. Brushes. B. F. Fransen. To: John A. Fransen Ltd.

A hairdresser's neck brush with a hollow polythene (polystyrene; polyvinyl chloride) handle containing powder to be squeezed out through the bristles.

B.P. 787,802. Method of and apparatus for packing liquid or paste-like substances in containers of synthetic thermoplastic material. To: Farbwerke Hoechst A.G. vormals Meister Lucius & Bruning (Germany).

Two webs of sheet material are fed between upper and lower grid-like electrodes within a clamping frame and the inserted sheets are clamped together. The electrodes are provided with opposite moulding cavities and the sheets after heating pressed into the so-formed mould by the pressure of the charge. Welding follows.

B.P. 787,867. Production of flexible cellular materials from polyisocyanate reaction products. To: Goodyear Tyre & Rubber Co. (U.S.A.).

Formation of a thick skin and the necessity for trimming is avoided by exposing the reaction mixture to an atmosphere of ammonia while still foaming, curing or setting.

B.P. 787,890. Perforated draining board. I. Lathey.

The top perforated draining board and the undertray is made of semi-rigid plastic material. (Add. to 721,188.)

B.P. 787,897. Brooches of other ornaments for personal wear. N. J. Arthur.

A Perspex container to be attached to the clothing of the wearer, filled with a liquid preservative (diluted formaldehyde) in which the natural body of a fish is immersed.

B.P. 788,012. Containers. H. Senior, F. Greaves. To: British Xylonite Co., Ltd.

A rigid (plastic) base is introduced into a thermoplastic flexible tube and sealed to the tube by welding down a wall strip adjacent to the expanded annular rib.

B.P. 788,013. Manufacture in continuous form of printed bags of polyethylene or other thermoplastic material. F. T. H. Hayes. To: Metal Box Co., Ltd.

Simultaneous transverse sealing and perforation of a flattened tubular web to form the bottom of one bag and the mouth of an adjoining bag. The printing is effected in synchronism with this operation.

B.P. 788,062. Polyurethane resin moulding materials. A. C. Cornwell. To: National Research Development Corp.

A polyurethane resin (an alkyd reacted with a polyisocyanate) which foams during curing and remains expanded is mixed with a filler (fibre or powder) in such proportions (20% or more) that the material is dough-like and can be handled manually. Immediately after mixing, the material is cooled so as to inhibit curing. In cooled solid condition it can then be ground and stored until inserted in a mould and cured by raising the temperature again.

B.P. 788,063. Moulding reinforced plastic tubes. D. N. Davies. To: Distillers Co., Ltd.

B.P. 767,118 describes a process for making an article from bonded glass material characterised by a mould of a polymerised styrene compound which becomes part of the article. This process can be applied to the production of tubes or cylinders in a rotating mould in which the fibres are placed between the inner wall of the mould and the outer wall of a perforated inner tube through whose perforations an introduced liquid resinous composition drains under centrifugal force bonding the fibres after curing while still rotating.

B.P. 788,133. Method and apparatus for shaping plastic foams. J. L. McCurdy, C. E. DeLong. To: Dow Chemical Co.

Plastic foam sheets of uniform thickness by extruding a flowable gel from a pressurized chamber into a horizontal slot-like passageway between parallel shaping members usually 1 to 10 inches from the extrusion orifice.

B.P. 788,148. Closures for containers. J. M. Jackson. To: Metal Box Co., Ltd.

The sealing element for the bottle, jar or the like is moulded with the closure (of polythene, polystyrene or other resilient material) in the shape of a flexible annulus at an angle to the axis of the closure.

B.P. 788,178. Toothbrush container. P. Tucker.

Containing also a tube for dentifrice, toothpicks, etc., and an (antiseptic) dehydrating agent for the wet brush.

Cooling Power Cables by Plastic Pipe

PIONEERING work in the cooling of underground power cables is being carried out by the Hydro Electric Power Commission, of Ontario, by the use of water-carrying plastic pipe.

Faced with the problem of relocating a long length of overhead transmission line because of the construction of the new Frederick G. Gardiner Expressway, the decision was taken to replace the old overhead line, supported by 31 steel towers, with underground transmission facilities.

One of the problems of underground power cables is the limitation of the amount of power which can be transmitted without overheating the cables. Heating of the cables is not uniform because whenever the cables pass through soil with a low heat conductivity hot sections develop so limiting the amount of electrical power which can be transmitted.

Engineers in the Commission's Research Division have developed a method of overcoming this difficulty by the use of plastic pipe carrying cooling water.

In their investigations the Hydro Electric Commission found that polythene piping had many advantages over conventional metal pipe as a water carrier for this purpose. It is flexible, easy to handle, and is virtually immune from corrosive attack.

Four 115,000-volt transmission circuits are being constructed, cooling of each group of three cables being carried out by two polythene pipes of ¾ in. inside diameter placed between the cables.

A total of 37 miles of piping was made to the specification of the Commission and formed part of the longest cable-laying operation of its kind carried out in Ontario.

Where the cables had to pass through ducts a duct was used for each cable, and two ½ in. bore plastic pipes were used to carry cooling water so that overheating did not occur in the pipe.

In service the plastic cooling pipe will utilize water from the town water mains. At intervals of every 1,600 ft. to 2,000 ft. the water in the polythene pipes will be discharged to the sewers and a fresh supply of cool water drawn into the pipes. Over this distance it is estimated that the temperature will be raised by approximately 10° C. This is naturally very wasteful of water and when the use of this system of cooling is extended it is anticipated that automatic controls will allow the water to flow only at predetermined temperatures.

This new development in the use of polythene pipe is expected to have far-reaching effects in the future in making it possible to transmit greater amounts of power through electrical supply cables.

Without the use of the plastic pipe the Hydro Electric Power Commission, of Ontario, state that each of the four circuits would only carry 140,000 kW. of power at 115,000 volts; by cooling the cables it is hoped that a 50% increase of power capacity will be obtained.

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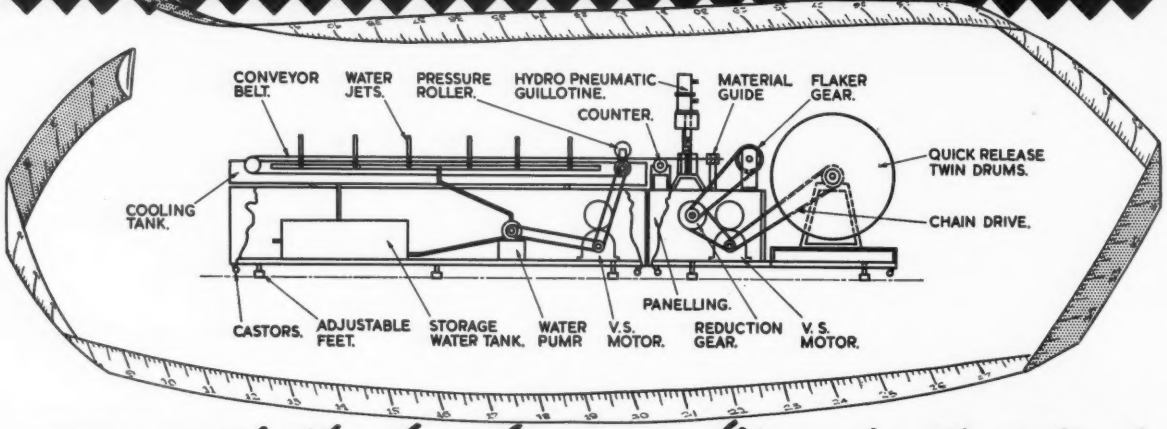

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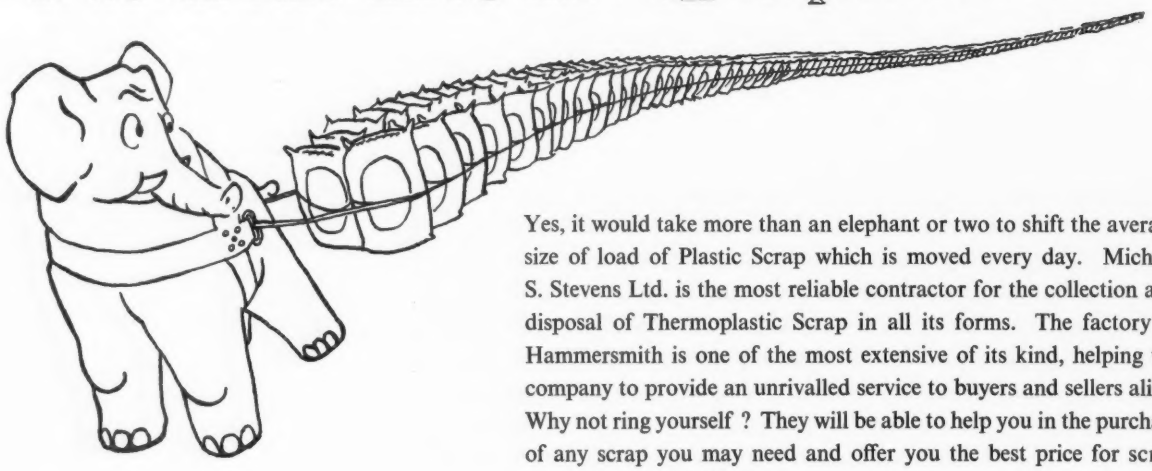

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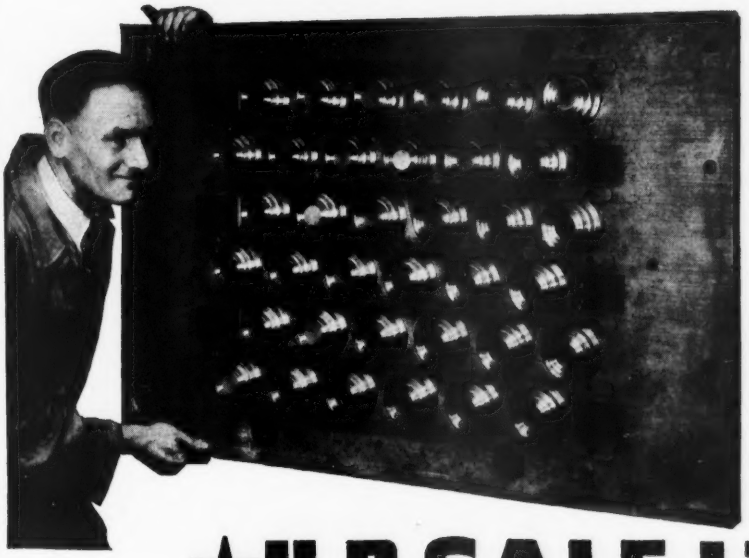

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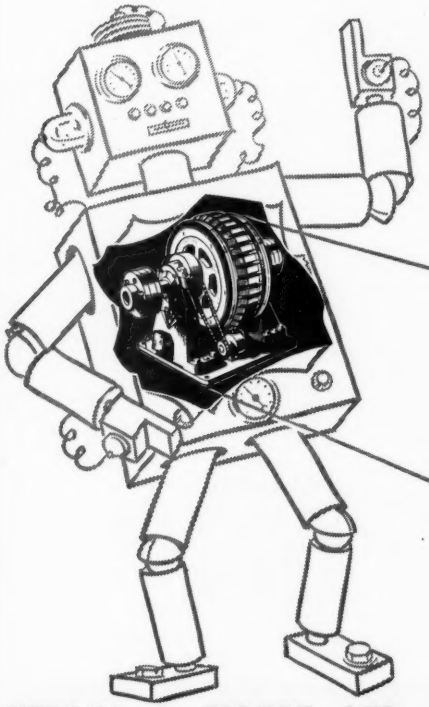

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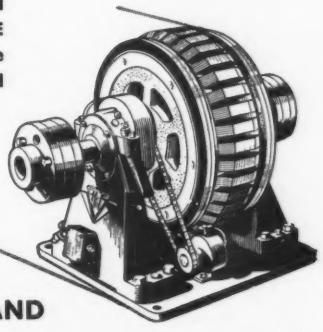

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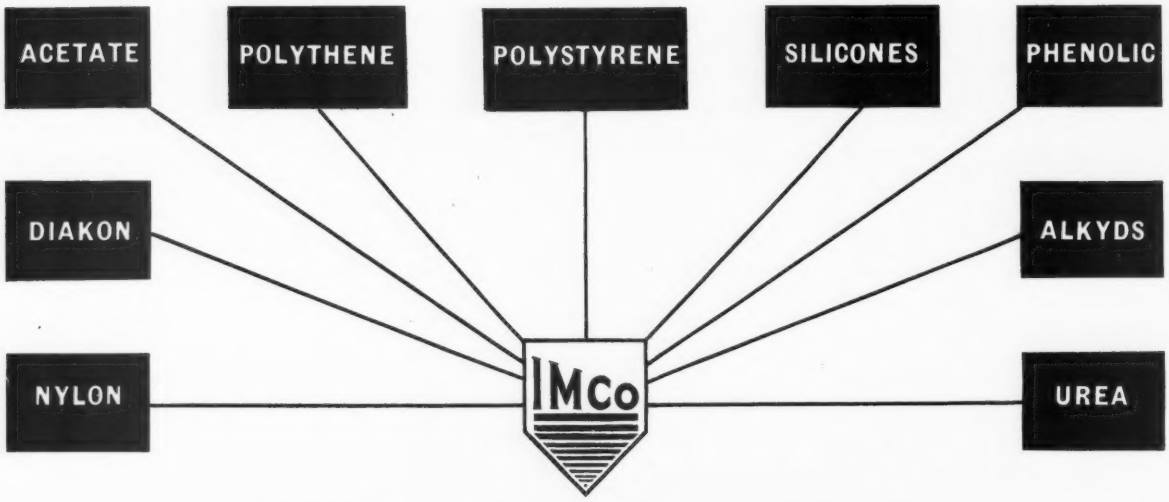

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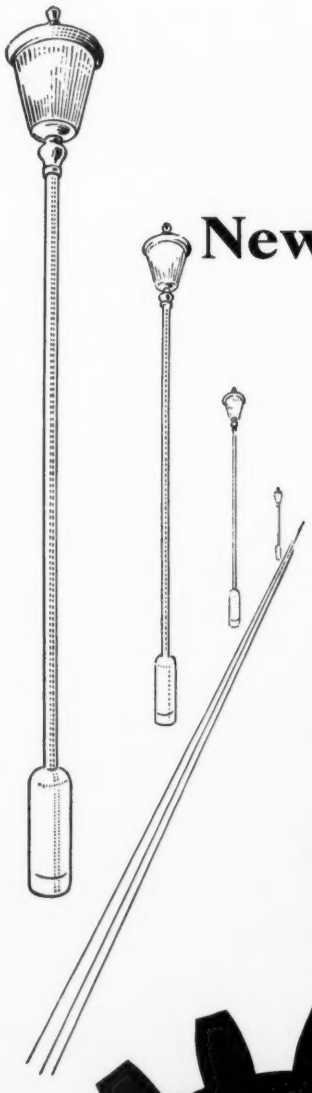

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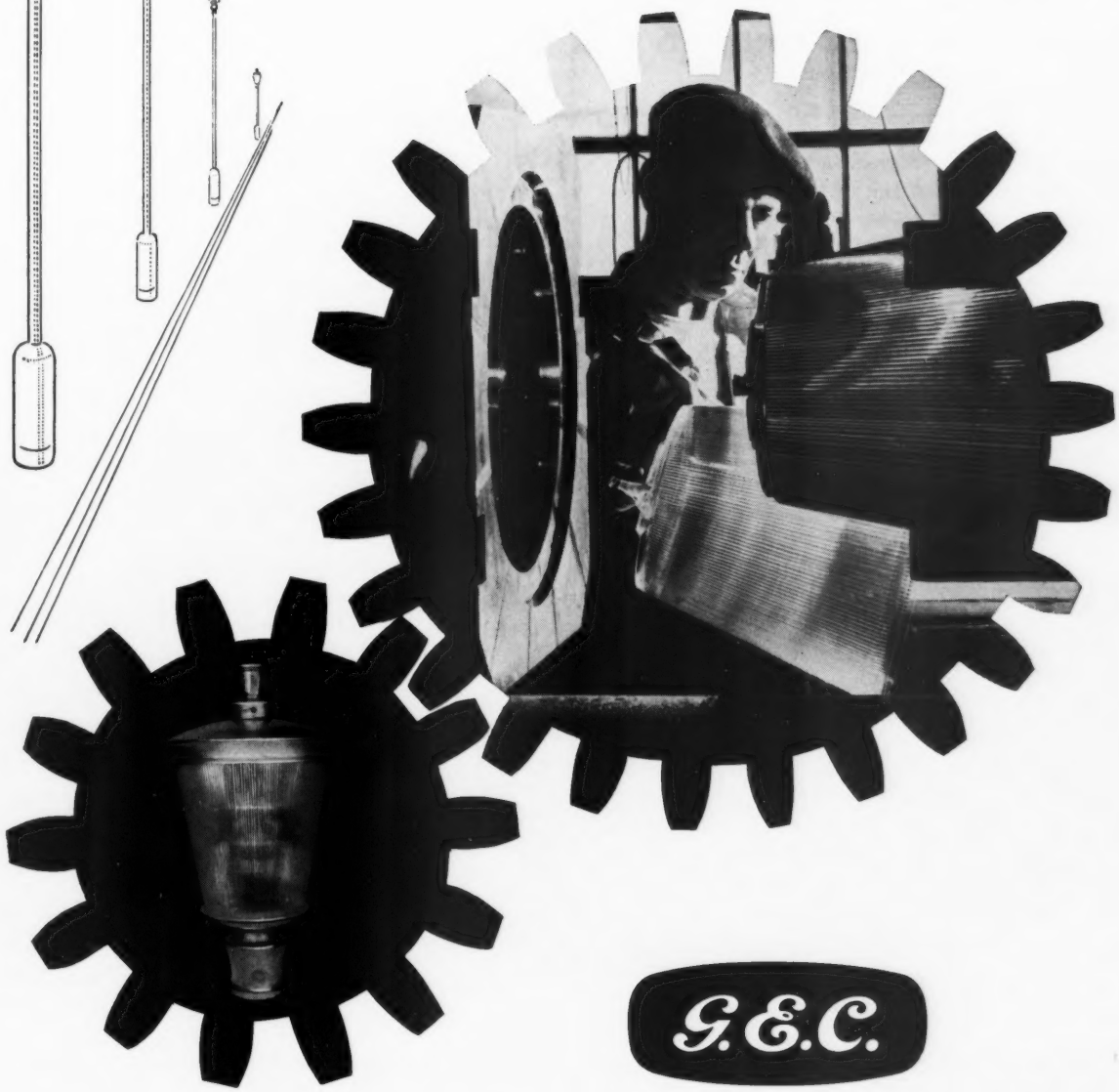

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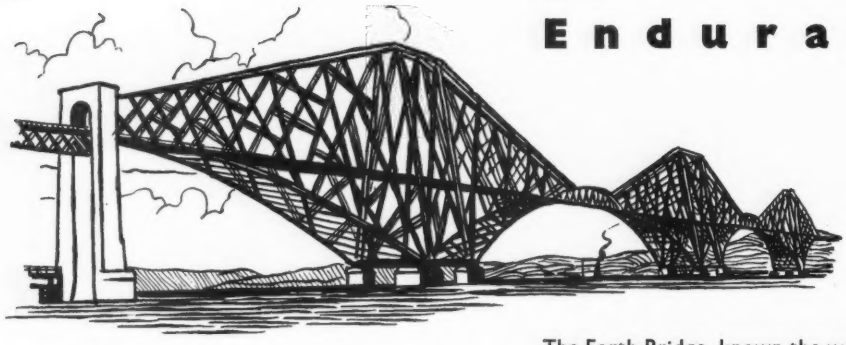

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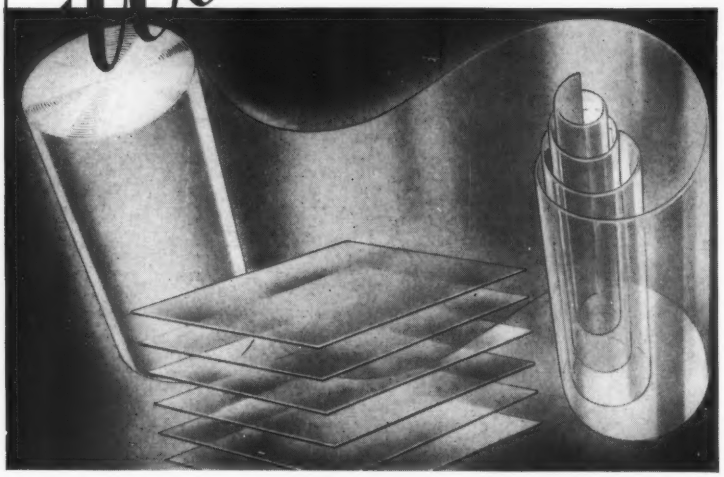

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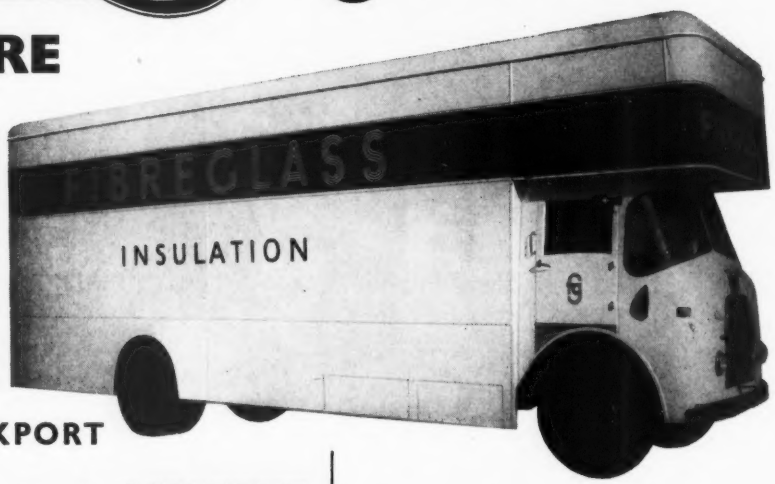

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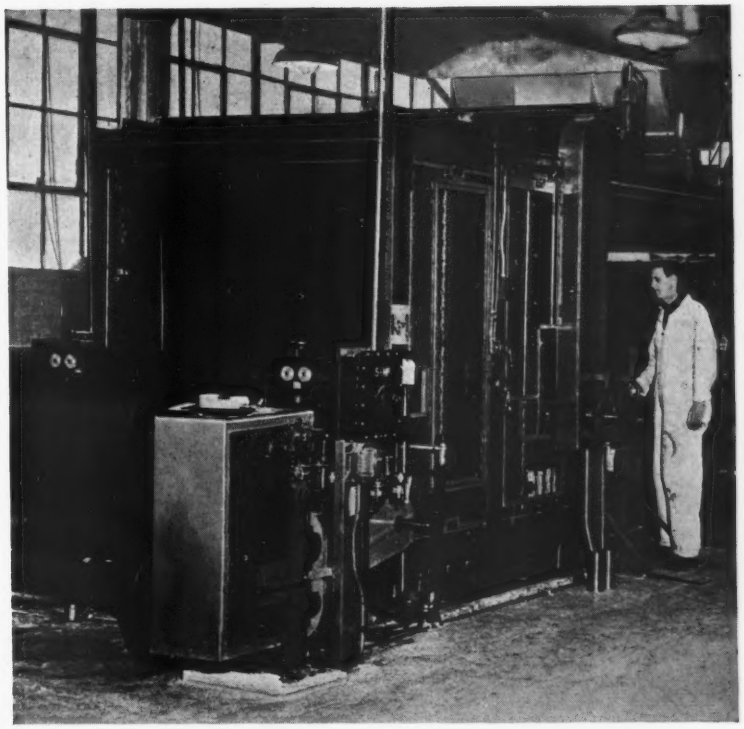

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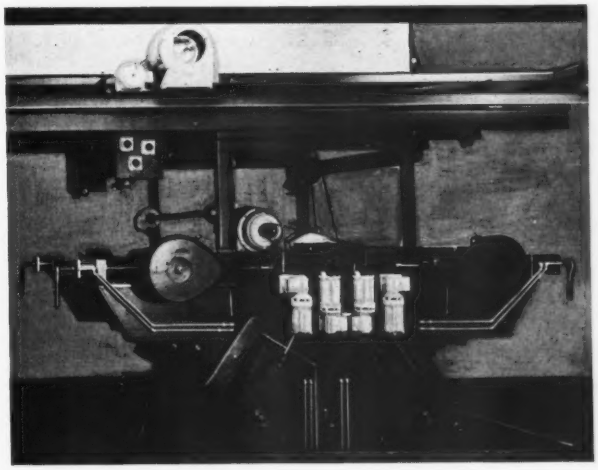

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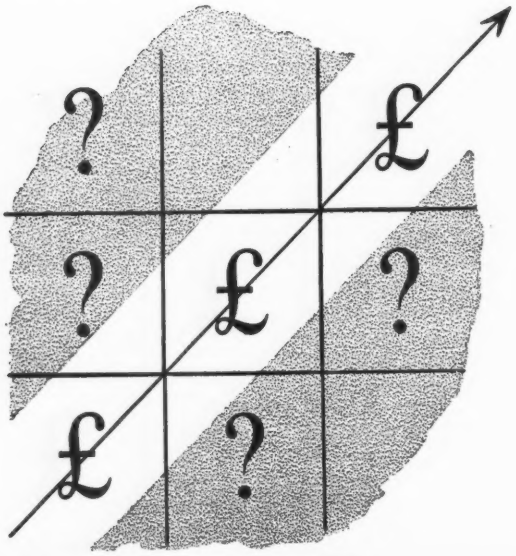

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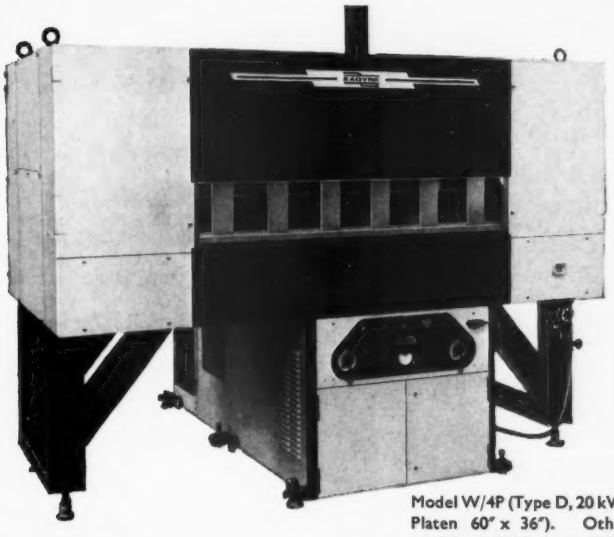

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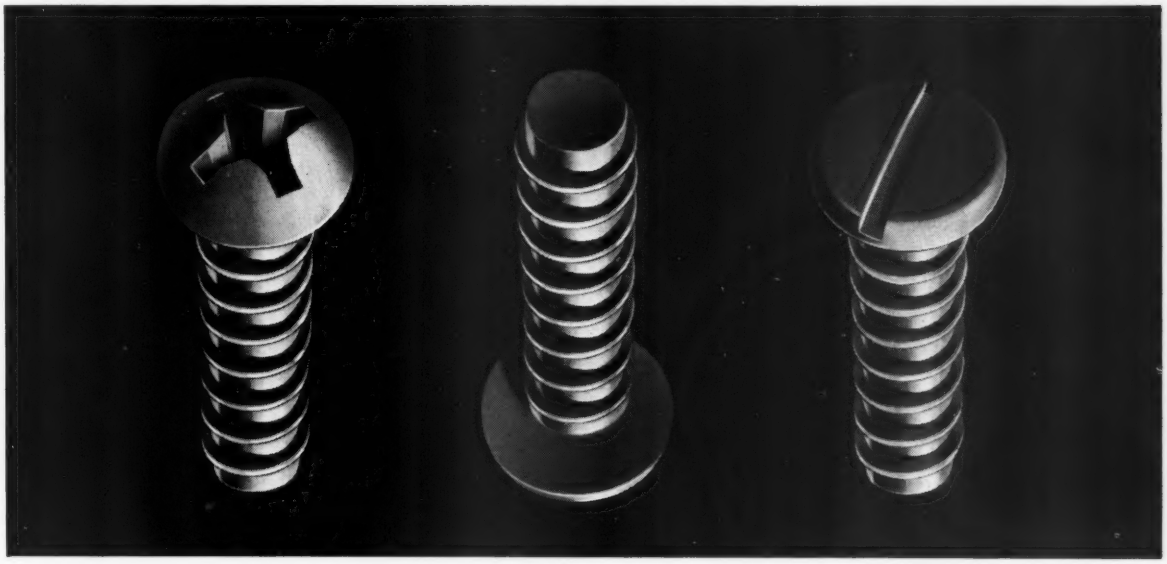

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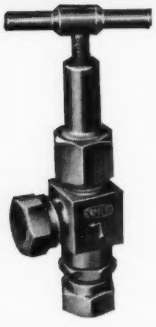

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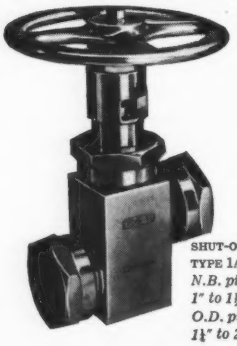

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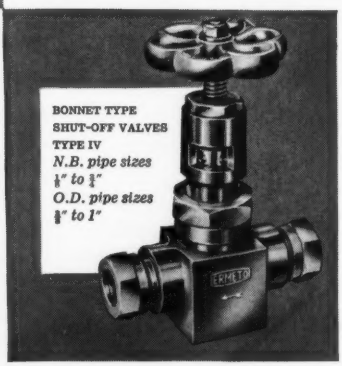

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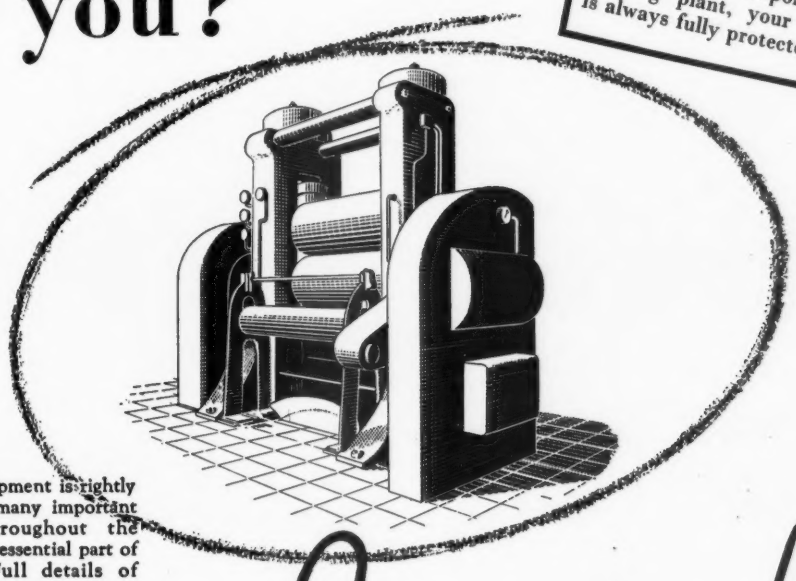

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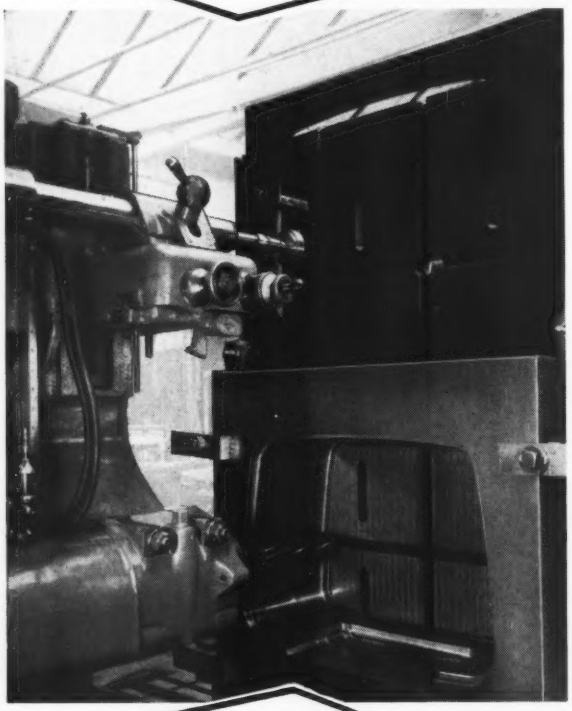

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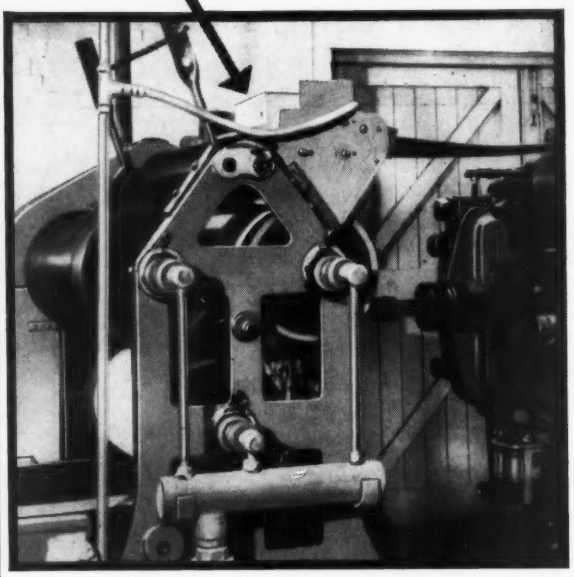

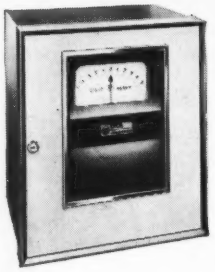

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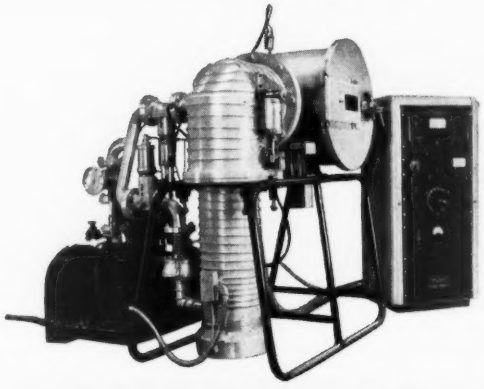

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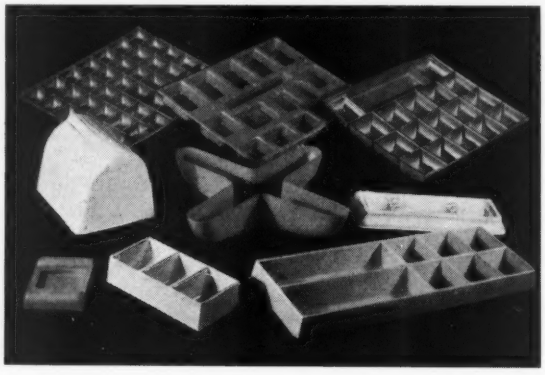

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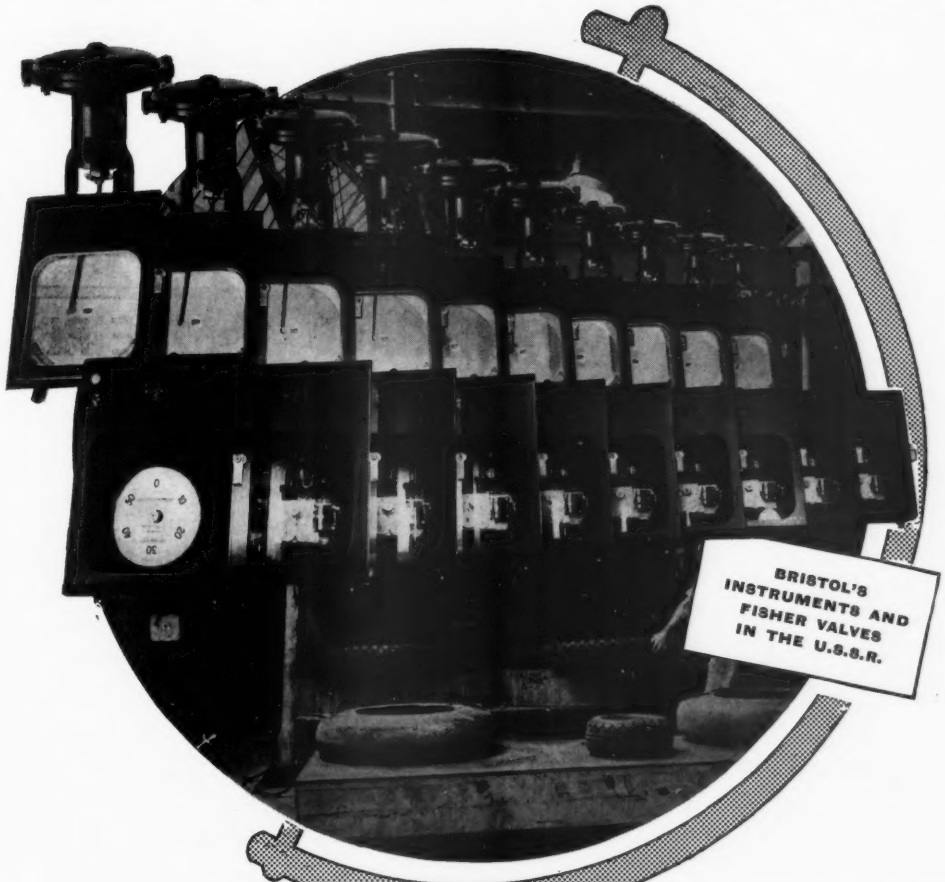

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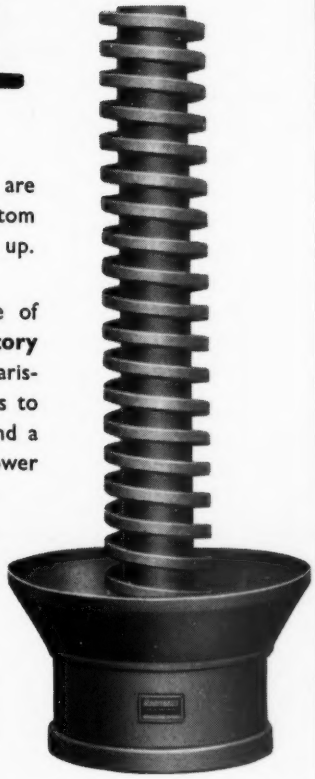

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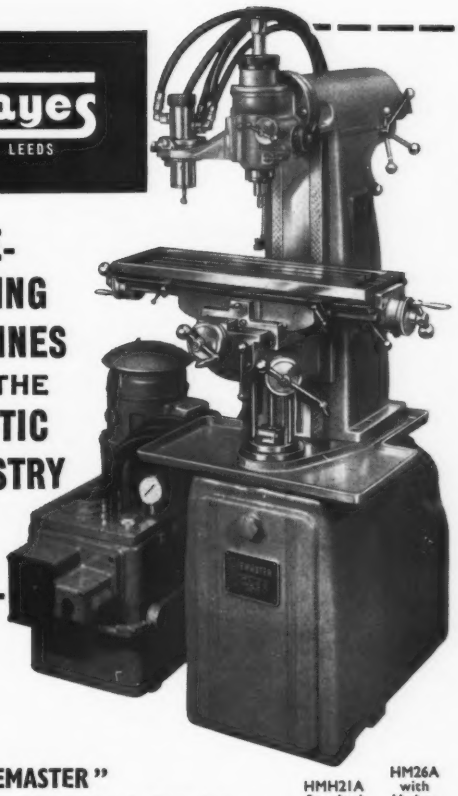

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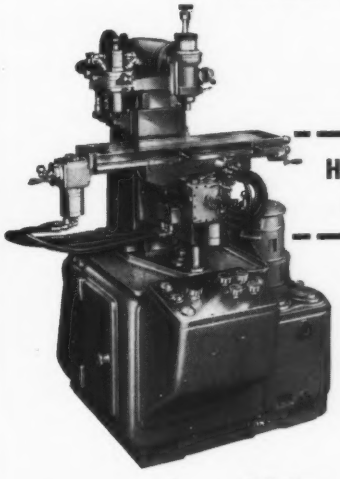

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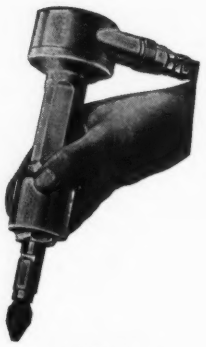

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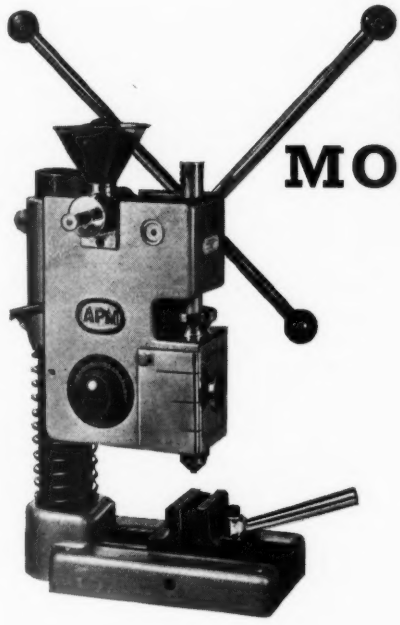

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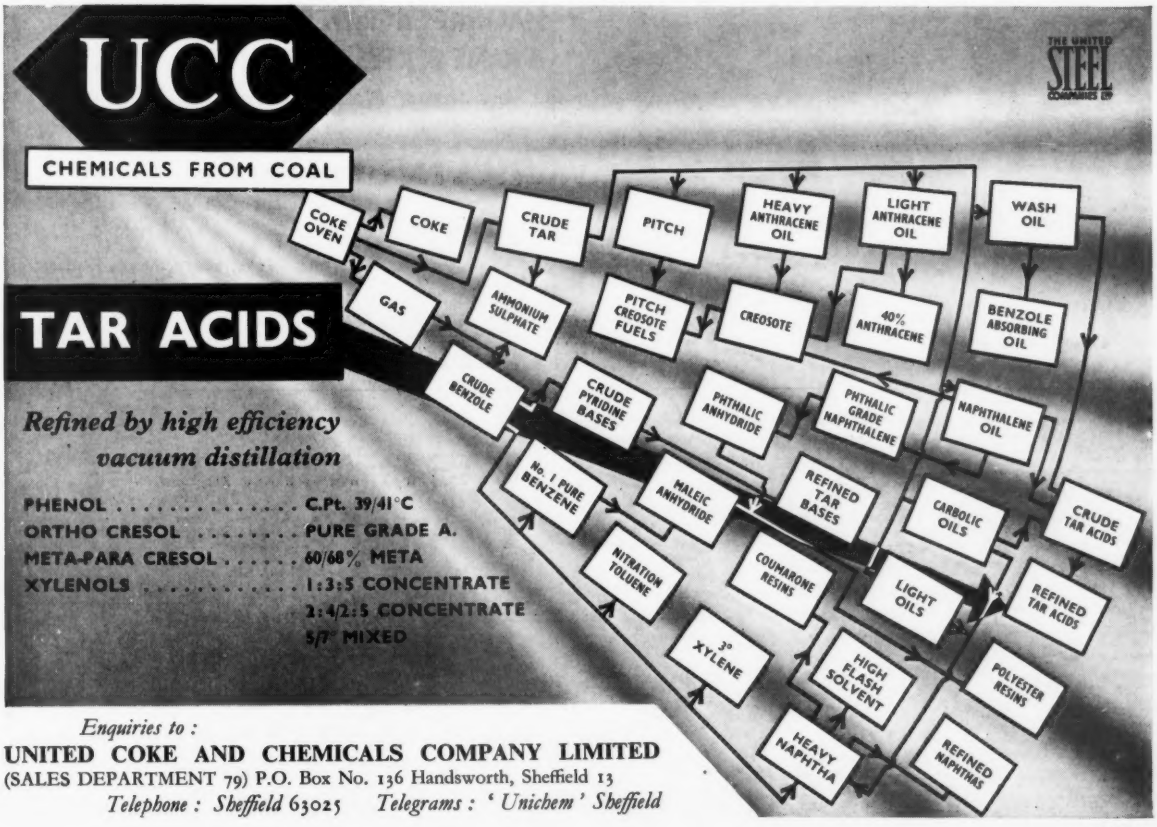

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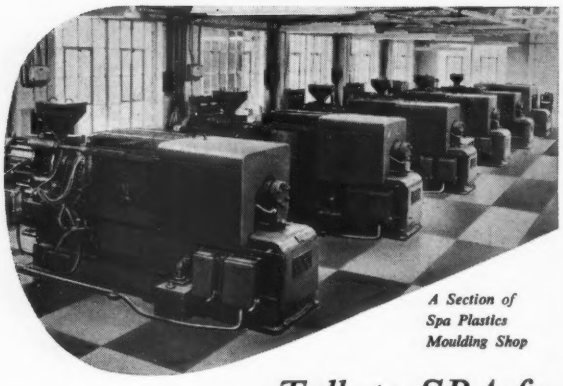

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Any Size of Plate or Letter

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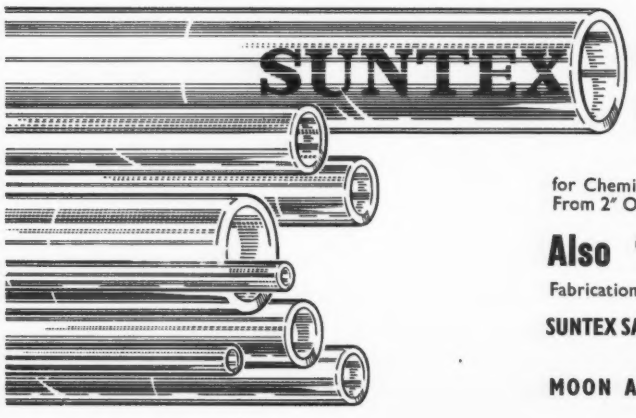
Telephone: Parkstone 1664



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PERFORATED METAL

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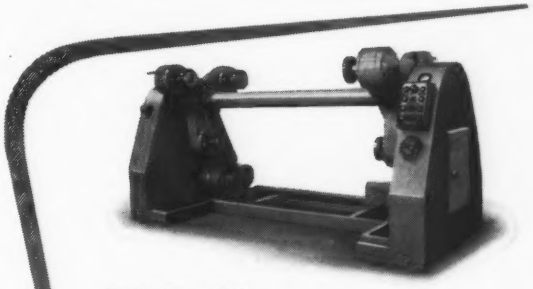

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We are cash buyers of merchandise of every description. Also Clearance Stocks. Discontinued Lines, Surplus and Redundant Stocks. Bottles, Jars, **Screw Caps, Cartons, and other Packaging Materials.** In fact, goods of all kinds can be disposed of through us without delay, on the most favourable terms, and without trouble.

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made simple and economical by METAL-WOODS precision brass rule

Available with plain and decorative faces, including the Metal-Woods 'CUT-SEAL' double faced rule for simultaneous welding and cutting

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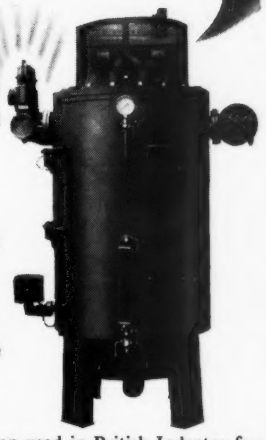

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- ✱ **No fire risk. Will go beside machines using steam**

B & A Electrode Boilers have been used in British Industry for over 25 years. They are more convenient, more compact than any other steam raisers. Users say "The advantage in our food factory is tremendous." "Steam pressure keeps more constant than any other type of boiler." *Write for Catalogue 1.F.*

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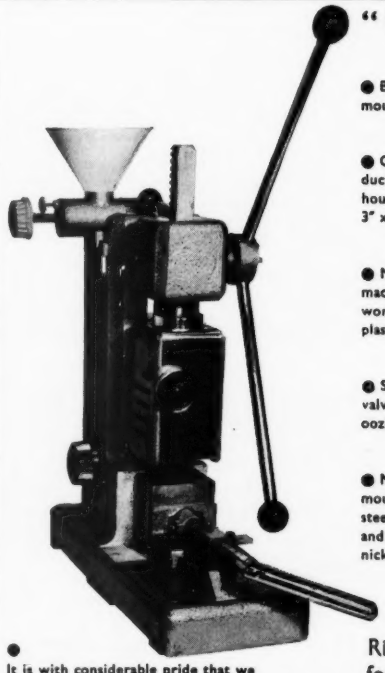

- ● Bench-type injection moulding machine.
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- ● Most comprehensive mould service in stainless steel, nickel chrome steel and electro-formed hard nickel tools.

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The simplicity of operation, coupled with the low cost of moulds, makes this the most versatile machine of its kind on the market.

Ring TER 9648 for particulars

Manufactured by

PEPCO LTD.

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A complete system available for heat, light and dielectric requirements.

Stabilisers for P.V.C.

✱ **Basic Lead Carbonate** — specially prepared for P.V.C. Supplied only as dispersed paste with Plasticisers to choice.

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Lead Stearate
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** With the exception of Basic Lead Carbonate (which is supplied only as dispersed paste) all the above products can be supplied dry or dispersed in plasticisers.*

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SPECIAL CHEMICALS DIVISION, CRESCENT HOUSE, NEWCASTLE UPON TYNE, 1, ENGLAND.

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We welcome enquiries to grind customers' own material

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...a complete dispersion to your own specification, containing WHITE LEAD STABILISER, LUBRICANT, FILLER & COLOURING MATTER?

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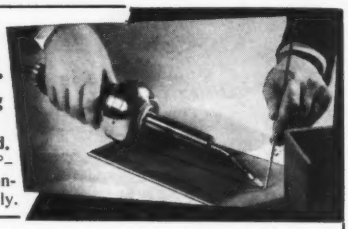
LK Plastic Welding Tools

No compressor required. Hot airstream, 180°–500° C., simply by connecting to mains supply.



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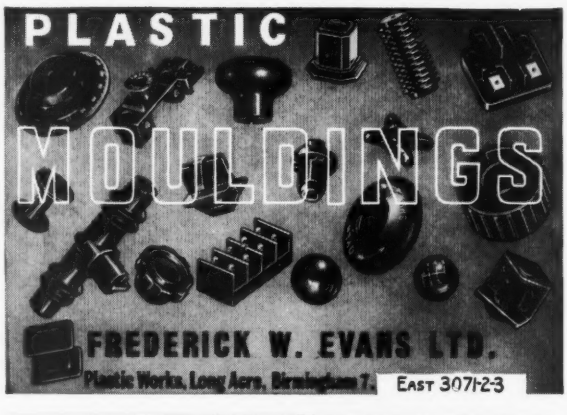

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Medium tube 3/6 Standard tube 8/6

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Plastics Classified Advertisements

PRESS DAY.—Classified advertisements for the May issue must be received at Head Office by first post Monday, April 28.

Last-minute additions and deletions are accepted by telephone from trade advertisers up to noon. Advertisements received too late for a particular issue are automatically inserted in the succeeding one unless instructions to the contrary are received.

RATES.—6d. per word (minimum 12 words 6/-). Each paragraph charged separately and name and address must be paid for. Semi-displayed setting 2 gns. per single column inch. Series discounts of 5% for 6, and 10% for 12 consecutive insertions allowed to trade advertisers.

TERMS.—Strictly net and prepayable. Monthly accounts for settlement by the end of the month following insertion are allowed to trade advertisers if satisfactory references are provided.

REMITTANCES.—Cheques and postal orders should be crossed and made payable to TEMPLE PRESS LIMITED and instructions sent addressed to the Manager, "Plastics," Bowling Green Lane, London, E.C.1.

THE PROPRIETORS retain the right to refuse or withdraw advertisements at their discretion and are not responsible for clerical or printers' errors although every care is taken to avoid mistakes.

BOX NUMBERS.—Private advertisers desiring to have replies sent care of "Plastics" may do so on payment of 1/- to cover booking and postage, plus cost of four extra words. Box numbers must not be used for the purpose of circularizing and the proprietors do not undertake the distribution of such matter received. To avoid mistakes in forwarding, Box numbers should be carefully and legibly copied and replies sent to Box P000, care of "Plastics," Bowling Green Lane, London, E.C.1.

DEPOSIT SYSTEM.—Facilities are available to readers to purchase advertised goods on approval by depositing the purchase price with "Plastics." Full details on application. Commission 1% (minimum 2/-) on amount deposited.

HEAD OFFICES.—Bowling Green Lane, London, E.C.1, England. Telephone: Terminus 3636. Telegrams: "Pressimus, London Telex," Telex: 23839.

BRANCH OFFICES: Bayliss House, Hurst Street, Birmingham, 5. Telephone: Midland 6616. 50, Hertford Street, Coventry. Telephone: Coventry 62464. 1, Brazennose Street, Manchester; Telephone: Deansgate 6114-8. 12, Renfield Street, Glasgow. Telephone: Glasgow Central 1413.

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TO LET
NEW OFFICE-SHOWROOM
AND
INDUSTRIAL BUILDING.
AREA 20,000 SQ. FT.
LOADING DOCK. CENTRAL HEATING.
PASSENGER/GOODS LIFT.
NEW LEASE. REASONABLE RENT.
SOLE AGENTS.
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247-24

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AUTOPLAX Glass Fibre Experimental Kits containing glass fibre mat, woven glass cloth, polyester resin, catalyst, accelerator and full instructions for use. All items available separately ex-stock. Kits at 19s. 4d., 32s. 1d., 47s. 8d., £6 and £9 10s. 0d., post free, Automobile Plastics, Co., Ltd., Autoplax House, 62–64 High St., Barnet, Hertfordshire. Barnet 9147. Telegrams: Autoplax-Barnet. zzz-167

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BOOTHS Motor Insurance Specialists.
Booths for Private and Business Cars.
Booths No Claim Bonus 33% to 50%.
Booths (Insurance), Ltd., (P), 6 Booth Street, Manchester, 2. zzz-163

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THOMPSON FOUR-COLUMN OILDRAULIC PRESS. With upstroke and Bradley & Turton horizontal pump, for sale. Pressure exerted about 7 tons. Stroke 36 in. Between columns 9½ in. × 4½ in. The head is adjustable 9½ in. × 9½ in. Diameter of ram 3 in. Overall height of press 11 ft. Maximum daylight 6 ft. 6 in. F. J. Edwards Ltd., 59 Euston Rd., London, N.W.1, or 41 Walter St., Birmingham, 3. 247-9

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Hydraulic Presses of all sizes. Injection Machines
Extruders. Mixing Mills. Hydraulic Pumps and
Accumulators.
Send your requirements to the specialists.
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REPLANT WORKS,
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Phone: Woolwich 7611. 247-34

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Included are all piping, couplings, interlock front and fixed side and back operator guards.
Inspection by appointment, London area.
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WESTMINSTER POWER-OPERATED
INJECTION MOULDING MACHINES,
IN FIRST-CLASS CONDITION.
Write, stating price required, to:
Box P475, care of "Plastics." 247-13

Machinery, Tools and Plant Wanted (contd.)

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MOULDS TO YOUR SATISFACTION
AND OURS.
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zzz-146

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ENGRAVING. HEAT-TREATMENT.
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LEIGH TOOL & GAUGE CO., LTD.
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Production Capacity Available (contd.)

PLASTICS (MANCHESTER), LTD.,
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SPECIALISTS IN
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LONDON ROAD, MANCHESTER, 1.
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PROTOTYPE AND REPETITION.
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STOCKISTS AND FABRICATORS OF "FORMICA."
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FOR MACHINE ENGRAVED LABELS in Plastic don't forget Precision Units Ltd., Seacrest Works. Parkstone (1664), Dorset. Quick deliveries. Keen prices. 222-156

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Polystyrene.
Cellulose acetate.
Polyethylene.
P.V.C.
Polyvinyl butyral.
Perspex and Diakon.
Send now for details.
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P.V.C. SHEET SCRAP, clean, sorted to colour and grade available all times. Suitable extrusions, compounding, flooring, etc. Derrick Davis Plastics, 90/92 The Chase, S.W.4. Macaulay 8666. 247-xa6043

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Enormous quantities in all sizes and colours, cheap to clear. Write for stock lists and prices to :
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TRADING ESTATE, WEST HARTLEPOOL.
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HERBERT CONNOR LTD., Buyers of all Scrap. Top prices paid on any terms for Polythene, Polystyrene, Diakon, Perspex, P.V.C., Acetate, Nylon, in lump, scrap articles, ground and re-ground forms and film offcuts. Please send samples and details to: 120 Beaufort Park, London, N.W.11. 247-37

WE REQUIRE large regular supplies of Nylon Scrap. Shavings, Lumps and Rejects. Box P4714, care of "Plastics." 247-19

DERRICK DAVIS PLASTICS. P.V.C. scrap, redundant p.v.c. sheeting, extrusions, polythene styrene scrap, etc. Enquiries to 92 The Chase, S.W.4. Macaulay 8666. 247-xb6043

WANTED, Polythene scrap. Write to Box P221, care of "Plastics." zzz-132

SPOT CASH BUYERS of all thermoplastic injection scrap and redundant virgin lots. Regular collections. WG Plastics, 14 Cambridge Park Mews, Twickenham. Middlesex. Popesgrove 1800. 258-1305

POLYETHYLENE MOULDING POWDERS, lay-flat tubing and scrap of all kinds wanted against prompt cash payment. Box P398, care of "Plastics." zzz-147

POLYTHENE SCRAP: top prices paid on any terms for any form of polythene scrap, i.e. extrusion lumps, scrap articles, film offcuts, ground and re-ground forms. Please send details and samples to· Herbert Connor Ltd., 120 Beaufort Park, London, N.W.11. 247-38

BROCKWELL PLASTICS LTD., 50 Hollingbourne Rd., S.E.24, will purchase redundant polyethylene scrap of all kinds. We collect and pay cash on collection. Box P399, care of "Plastics." zzz-148

WANTED all types of Polythene Scrap. Send details and samples to: Tyruplex, Ltd., 111 High St., N.W.10. Elgar 2684. 247-31

THERMOPLASTIC SCRAP. We always buy large and small quantities and pay prompt Cash. Send offers to J. W. Nash & Co. Ltd., 27 Beethoven St., W.10. Ladbroke 4655/6/7. 247-29

WE REQUIRE large regular supplies of Nylon Scrap, Shavings, Lumps and Rejects. Box P332, care of "Plastics." 247-30

ALL GRADES of nylon scrap required. Box P408, care of "Plastics." 247-32

LEEPLAS PRODUCTS require all types of scrap: p.v.c., polythene, polystyrene, etc., in any form. Best prices paid. Details and samples to: Canal Wharf, Canal St., Leigh, Lancs. 248-1263

REFRIGERATION & AIR CONDITIONING PLANT

FRIGIDAIRE LOW TEMPERATURE REFRIGERATORS, 49 in. wide × 28 in. deep × 34 in. high. Ext. Ex large national user, suitable A.C. or D.C. deep freezing, storage of ice-cream, frozen foods, etc. Price £40 each. Domestic refrigerators, service cabinets, and cold rooms also available. A.R.C., 134 Great Portland St., London, W.1. MUSeum 4480. zzz-171

SITUATIONS VACANT

TOOLMAKER required. Experience moulds essential. Permanent and high rate. Seaforth, 60 Oakhurst Rd., Southend, Essex. 248-1052

FOREMAN MOULDER required. Small shop near London. Essential fully experienced. Write Box P463, care of "Plastics." 248-1258

DESIGNER-DRAUGHTSMEN required for Plastics Machinery preferably with experience in Extrusion and ancillary equipment. Good working conditions and non-contributory Pension Scheme in operation. Write in confidence giving full details of experience, age, salary required, to N. Browne, Bone Bros., Ltd., Manor Farm Rd., Alperton, Wembley. 248-1303

Situations Vacant (contd.)

DEVELOPMENT CHEMIST

An expanding research and development programme has created the need for a Qualified Chemist in the Technological Department of the Development Division of Smith & Nephew Research Ltd. This company is the research organization for Smith & Nephew Associated Companies, manufacturers of surgical dressings, adhesive plasters, plastic films, cosmetic, toilet and ethical pharmaceutical preparations. Applicants should have a practical bias and experience in at least one of the fields, textiles, plastics or adhesives is desirable though not essential. Factory problems and the transfer of processes from Research Company to Manufacturing Companies are also part of the Development Divisions fields of operation. The position is a progressive one for a man with a versatile outlook, and salary will be according to age, qualifications and experience. Write to: Technical Secretary, Smith & Nephew Research Ltd., Hunsdon Laboratories, Ware, Herts. 247-36

GOLDEN OPPORTUNITY for Designer-Draughtsman with small and progressive firm of moulders, compression and injection. Only those with the necessary experience and qualifications who are prepared to work hard and take responsibility with a view to executive position, need apply. Write stating full details of experience and salary required. Box P479, care of "Plastics." 248-1302

SHELL CHEMICAL COMPANY, LIMITED

has a vacancy at its Laboratories at Partington (Cheshire) for an

INJECTION MOULDING SPECIALIST

for technical service work on thermoplastics. Applicants should be aged 25–35 and have had suitable experience. A qualification in plastics, science or mechanical engineering would be an advantage.

Salary according to age, qualifications and experience. Generous pension scheme and other benefits.

Write with full details to:—

SHELL CHEMICAL COMPANY, LIMITED,
Personnel Dept., 170 Piccadilly, London, W.1.
247-28

WE REQUIRE an experienced and energetic man to take charge of our Compression Moulding Shop. Must be capable of obtaining highest possible output from both man and machine. Permanent and well-paid position to the right man. Apply with full details of experience, age and salary required, Seaforth, Watchett Works, Oakhurst Rd., Southend-on-Sea. 248-1299

CHEMISTS

Graduate chemists are required for applied research on cast resins for use in electrical and electronic equipment. A young man who has completed his National Service and is interested in new polymers and methods of using them would have considerable scope to develop his ideas.

Applications, quoting reference W.10 should be made on the appropriate form obtainable from:—

PERSONNEL MANAGER,
METROPOLITAN-VICKERS ELECTRICAL Co., LTD.
TRAFFORD PARK, MANCHESTER, 17.
248-1300

ASSISTANT SALES MANAGER required for Cellulosics Division. Applicants must have good commercial experience and educational background. Age 25 to 35 years. Applications will be dealt with in confidence and should be addressed to: Sales Director, B.X. Plastics Ltd., Head Sales Office, Higham Station Avenue, Chingford, London, E.4, marked "Reference A.3." 247-25

SALES MANAGER. An opportunity for a man with experience of the rubber and plastics industry and the ability to plan and organize a sales campaign; a knowledge of plastic and rubber coated textiles will be helpful. Age between 35 and 45 years, though consideration will be given to a man outside these limits if he has a proved record of his ability. Salary £1,200–£1,500 per annum with eligibility for Pension Scheme. Head Office in Manchester area. Box P4712, care of "Plastics." 247-18

B.X. PLASTICS LTD. require additional representatives in the London and Home Counties areas, experience in the plastics industry an advantage but not essential. Applicants must have good commercial experience, and educational background. Age 25 to 35 years. Applications will be dealt with in confidence and should be addressed to: Sales Director, B.X. Plastics Ltd., Head Sales Office, Higham Station Avenue, Chingford, London, E.4, marked "Reference REP." 247-22

ASSISTANT SALES MANAGER required for Polythene Sales Division. Applicants must have good commercial experience, preferably in the packaging trade, and a good educational background. Age 25 to 35 years. Applications will be dealt with in confidence and should be addressed to: Sales Director, B.X. Plastics Ltd., Head Sales Office, Higham Station Avenue, Chingford, London, E.4, marked "Reference A.1." 247-21

Situations Vacant (contd.)

FOREMAN required for plastic moulding shop, South Manchester, with experience of both injection and compression moulding. Applicants, preferably aged about 30, should be capable supervisors possessing initiative and tact. Apply Box P4711, care of " Plastics." 247-16

ASSISTANT SALES MANAGER required for P.V.C. Sales Division. Applicants must have good commercial experience preferably in the p.v.c. trade and a good educational background. Age 25 to 35 years. Applications will be dealt with in confidence and should be addressed to: Sales Director, B.X. Plastics Ltd., Head Sales Office, Higham Station Avenue, Chingford, London, E.4, marked " Reference A.2." 247-23

JOHNSON, MATTHEY & CO., LTD.

have a vancy for a technical salesman in their Colours Division.

Candidates, aged between 25 and 30, should be of approximately degree standard in chemistry, and have had some experience of inorganic pigmentation problems, preferably in the paint or plastic industries.

The work will include some investigation into customers' queries and problems, both with the customer and with the Company's research laboratories.

Applications, giving details of age, qualifications, experience, etc., should be made in writing to the Secretary of the Company, 78 Hatton Garden, London, E.C.1. 247-11

THE PLASTICS DIVISION of Universal Metal Products invite applications for the position of manager at their Southport factory. Applicants should have a thorough knowledge of all thermoplastic moulding, with full experience in technical control and administration. Salary will be according to ability and experience. Applications which will be treated in strict confidence, should be addressed for the personal attention of the Managing Director, Universal Metal Products Ltd., Salford, 6.

TECHNICAL ASSISTANT (SENIOR), aged 24–30, required at Dunlop Research Centre for interesting work in a new field of plastic materials and products. Candidates should have G.C.E. advanced level or H.N.C. in Chemistry, or equivalent qualifications. Attractive conditions include monthly staff status, pension scheme and good amenities. Please write in confidence, giving age, experience so far and salary expected, to the Personnel Manager (J.M.141), Fort Dunlop, Erdington, Birmingham, 24. 247-1

EXPERIENCED night-shift foreman required for plastic injection moulding shop, excellent wages, North London. Box M473, care of " Plastics." 247-6

Situations Vacant (contd.)

T. J. SMITH & NEPHEW LTD., Hull, invite applications for vacancy for qualified Chemist, B.Sc. or A.R.I.C. Preference will be given to applicants with knowledge and experience in the fields of polythene, p.v.c., film casting and extrusion. Five-day week. A staff position which qualifies for admission to Pension Scheme after initial period of service. Applications giving personal particulars, qualifications and experience to Personnel Department. 247-3

BIRKBYS LTD., Liversedge, Yorkshire, require a Technical Sales Representative for the Southern Area based on their London Office. Applicant should (preferably) have some experience in the plastics moulding industry, and should have a good education and background. Age 25–30 years approximately. Salary paid will be according to experience, ability and qualifications. In the first instance applications should be addressed under confidential cover to: C. R. Todd, London Manager, Birkbys Ltd., 79 Baker St., London, W.1. 247-4

SMITHS OF ENGLAND.
PLASTICS TECHNICIAN

required by the Motor Accessory Division of S. Smith & Sons (England), Ltd.

The work involves the knowledge of thermosetting and thermoplastic moulding techniques. The successful applicant will have a wide experience of mould design together with the ability to organize proving runs and carry out investigations. Sound practical experience is essential.

Good working conditions and permanent prospects together with Welfare and Pension Schemes make employment with this progressive company an attractive proposition.

If you are interested and suitably qualified, write with details of age, experience, qualifications and present salary to: Mr. Squire, Smiths Motor Accessories, Cricklewood, London, N.W.2.

BELGIAN firm seeks very competent technician to assume direction of Fibreglass Plastic Department. Box M474, care of " Plastics." 247-7

PRODUCTION ENGINEER. An opportunity for a man with drive and the ability to accomplish improvements in the manufacture of coated textiles and rubber and plastic mouldings. Salary £1,000–£1,200 per annum with eligibility for Pension Scheme. Head Office in the Manchester area. Box P4713, care of " Plastics." 247-8

Situations Vacant (contd.)

PHYSICIST.
AUTOMATIC TELEPHONE & ELECTRIC CO., LTD.
LIVERPOOL,

have a vacancy for a qualified Physicist for their Laboratories at their Main Works at Liverpool.

Candidates should be of graduate standard or equivalent, with reasonable knowledge of Chemistry and the work is on projects involving insulating materials, dielectrics, and applied industrial physics. Not less than two years experience in this field is desirable.

The post will be on the permanent staff, with generous Contributory Pension Fund.

Full particulars of age, qualifications and experience should be sent to :—

THE PERSONNEL MANAGER,
A.T. & E. CO., LTD.,
STROWGER WORKS, LIVERPOOL. 247-41

COMPANY developing Textile-Synthetic-Resin composite products require Graduate Chemist, preferably with textile experience. The work calls for a responsible person with initiative, capable of carrying out and controlling development work on laboratory and factory scale. Salary £800/£1,000 per annum according to qualifications, etc. Superannuation scheme. Staff appointment. Write stating age, experience, etc., to Box P4721, care of " Plastics." 247-44

SITUATIONS WANTED

ENGINEER—SALES MANAGER, expert plastic machinery, 45, fluent German, connections home and abroad, seeks responsible position offering premium to initiative and imagination. Box P471, care of " Plastics." 247-x6178

GLASS FIBRE. Plaster model and mould maker in charge of glass fibre shop seeks similar position with scope for advancement. Box P4720, care of " Plastics." 247-x6290

INJECTION MOULDING FOREMAN, practical experience of Peco machines, tool setting, etc., requires simular situation; references. Box P4722, care of " Plastics." 247-45

TIME RECORDERS

FACTORY TIME RECORDERS. Service rental. Phone, Hop 2239. Time Recorder Supply and Maintenance Co., Ltd., 157–159 Borough High St., S.E.1. 257-1260

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INDEX TO ADVERTISERS

Name	Page
A	
Advertentiebureau de Bussy	94
Albright & Wilson (Mfg.), Ltd.	61
Alchemy, Ltd.	83
Armstrong Patents Co., Ltd.	86
Asmidar Plastic Moulding Machines, Ltd.	89
Associated Lead Manufacturers, Ltd.	93
B	
Bakelite, Ltd.	56
Baldwin Instrument Co., Ltd.	90
Barber & Duffy, Ltd.	82
Bastian & Allen, Ltd.	93
Beck Koller & Co. (England), Ltd.	52
B.I.P. Engineering, Ltd.	13
B.I.P. Tools, Ltd.	20
Birkbys, Ltd.	33
Blackfriars Rotary Cutters, Ltd.	62
Bradley & Turton, Ltd.	69
Brand, Ed., Ltd.	5
Bridge, David, & Co., Ltd.	46
Briggs Bros. (Engineers), Ltd.	88
British Celanese, Ltd.	39
British Ermeto Corporation, Ltd.	80
British Oxygen Co., Ltd., The	45
British Resin Products, Ltd.	36, 37
Burtonwood Engineering Co., Ltd.	35
BX Plastics, Ltd.	Inside Front Cover
BX Plastics, Ltd. (Miltoid Sales Division)	62
C	
Castle, John, & Co., Ltd.	90
Cellgrave Co., Ltd.	76
Cinema-Television, Ltd.	81
Cole, R. H., & Co., Ltd.	4
Commercial Plastics, Ltd.	53
Connor, Herbert, Ltd.	94
Coventry Motor & Sundries Co., Ltd.	32
Crystalate, Ltd.	42
D	
Derwent Plastics, Ltd.	11
Dunlop Rubber Co., Ltd.	50
Duraplex (Plastics), Ltd.	78
E	
East Anglia Plastics, Ltd.	3
Ekco Electronics, Ltd.	82
Elliott Bros. (London), Ltd.	85
Elliott, E., Ltd.	17
Elm Plastics, Ltd.	88
Empire Plastics (Birmingham), Ltd.	80
Erinoid, Ltd.	Front Cover
Evans, Frederick W., Ltd.	94
F	
Fawcett-Finney, Ltd.	48
Ferguson, James, & Sons, Ltd.	33
Follsain Wycliffe Foundries, Ltd.	88
Fraser, Andrew, & Co., Ltd.	18
Fraser, W. J., & Co., Ltd.	2
G	
Gauge & Tool Makers' Association, The	73
Geigy Co., Ltd., The	Back Cover
General Electric Co., Ltd., The	71
Genristo, Ltd.	72
Grilon & Plastic Machinery, Ltd.	49
H	
Harvey, G. A., & Co. (London), Ltd.	91
Hayes Engineers (Leeds), Ltd.	87
Heenan & Froude, Ltd.	67
Holmes (Preston), Ltd.	74
Holzverzucherungs A.G.	49
Honeywell-Brown, Ltd.	21
I	
Imperial Chemical Industries, Ltd., Plastics Division	51, Inside Back Cover
Industrial Plastics, Ltd.	54
Industrial Raw Materials Corporation, Ltd.	31
Islington Metal & Plating Works, Ltd., The	86
Insulation Equipments, Ltd.	7
Insulation Manufacturing Co. (Plastics), Ltd.	68
International Combustion Products, Ltd.	16
International Corporation, Ltd.	91
Iridon, Ltd.	53
K	
Kayser, Ellison & Co., Ltd.	10
Keith Cardale, Groves & Co.	92
Kemitype, Ltd.	66
Kent Mouldings	76
Ketch, F. A., & Son, Ltd.	92
Kimbell, John, & Co., Ltd.	41
Kleestron, Ltd.	14
L	
Lankro Chemicals, Ltd.	12
Lembo Machine Works, Inc.	75
Ly-Bak, Ltd.	86
M	
M. & B. Plastics, Ltd.	40
Marshall, C. & C., Ltd.	78
Melwood Thermoplastics, Ltd.	72
Mersey White Lead Co., Ltd., The	94
Metalin, Ltd.	68
Metal-Woods, Ltd.	92
Milton Engineering Co., Ltd.	86
Monsanto Chemicals, Ltd.	60
N	
Nash, J. W. & Co., Ltd.	94
Nash, William, Ltd.	38
National College of Rubber Technology	88
National Plastics (Sales), Ltd.	58
Negri Bossi & Co.	1, 15
North British Rubber Co., Ltd., The	44
P	
Pendry (Plastics), Ltd.	64
Pepco, Ltd.	93
Phoenix Rubber Co., Ltd.	92
Pickfords Tank Haulage Service	91
Piece-Parts & Assemblies	64
Plant Installations, Ltd.	65
Podmores (Engineers), Ltd.	87
Precision Units (Dorset), Ltd.	90
Punfield & Barstow (Mouldings), Ltd.	28
R	
Radio Heaters, Ltd.	77
Reliance Trading Co.	92
Resinoid & Mica Products, Ltd.	63
Resinous Chemicals, Ltd.	55
S	
Sale, H. B., Ltd.	67
Shaw, Francis, & Co., Ltd.	24, 25
Shell Chemicals Co., Ltd.	6
Simmonds Aerocessories, Ltd.	27, 79
Smith, Stanley, & Co.	34
Spa Plastics	90
Stamgo Manufacturing Co., Ltd.	94
Steele & Cowlishaw, Ltd.	70
Sterling Moulding Materials, Ltd.	47
Stevens, Michael S., Ltd.	66
Streetly Manufacturing Co., Ltd., The	19
St. Just, Theodore, & Co., Ltd.	84
Suntex Safety Glass Industries, Ltd.	90
T	
Tensile Products, Ltd.	84
Textile Paper Tube Co., Ltd., The	70
Turner Brothers Asbestos Co., Ltd.	43
U	
United Coke & Chemicals Co., Ltd.	89
United Ebonite & Lorival, Ltd.	59
Universal Metal Products, Ltd.	23
Utliex, Ltd.	74
V	
Vacuum Industrial Applications, Ltd.	83
W	
Welwyn Tool Co., Ltd.	94
West Instrument, Ltd.	29
Whiffen & Sons, Ltd.	22
Wickman, Ltd.	8, 9
Wiggins Teape & Alex Pirie (Sales), Ltd.	26

EDITORIAL AND BUSINESS NOTICES

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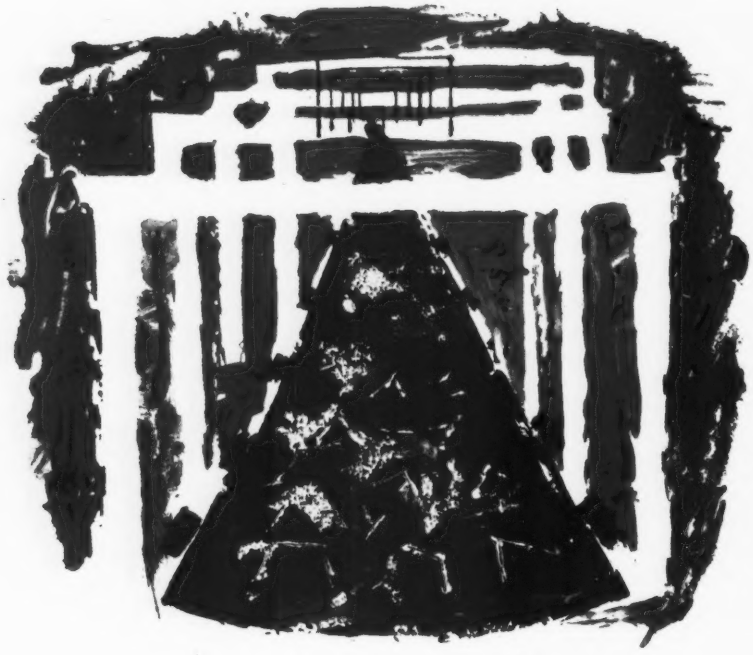
P.644

Vol. XXIII. No. 247 **Plastics** APRIL, 1958



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B2